"STUDIES ON YIELD AND QUALITY OF BARLEY (*Hordeum vulgare* L.) VARIETIES IN RELATION TO SOWING DATES AND NITROGEN LEVELS UNDER IRRIGATED CONDITIONS IN BUNDELKHAND"

THESIS

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THE BUNDELKHAND UNIVERSITY, JHANSI

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DOCTOR OF PHILOSOPHY
IN
AGRONOMY

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2002

CERTIFICATE

This is to certify that thesis work entitled "**Studies on Yield and Quality of Barley (*Hordeum vulgare L.*) Varieties in Relation to Sowing Dates and Nitrogen Levels Under Irrigated Conditions in Bundelkhand**" is an original piece of research work done by Mr. Vivek Kumar Chakrawarti under our co-supervision for the degree of Doctor of Philosophy in Agronomy of Bundelkhand University, Jhansi (U.P.)

We further certify that :

a) the thesis has been completed,

b) it embodies the work of the candidate himself,

c) it is an original piece of research work,

d) the thesis fulfils the requirement of attendance as laid down by the university, and

e) it is up to the standard both in respect of its contents and literacy presentation for being referred to the examiners.

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LIST OF ABBREVIATIONS

Words	Abbreviation
At the rate of	@
Centimeter	cm
Critical difference	C.D.
Co-workers	*et al.*
Date of sowing	D
Degree of freedom	d.f.
Degree of centigrade	°C
Days after sowing	DAS
Genotypes	G
Gram	g
Figure	Fig.
Fisher's value	"F" value
Mean sum of square	M.S.S.
Metre	m
Nitrogen	N
Non-significant	N.S.
Number No.	No
Per hectare	/ha
Phosphorus	P
Percent	%
Kilogram(s)	Kg
Quintal	q
Significant at 5%	*
Sum of square	S.S.
Standard error of means	S.Em. ±
Varieties	V
Nitrogen levels	$N_0=N_1=$Control
	$N_1=N_2=N_{30}=30$ Kg/ha.
	$N_2=N_3=N_{60}=60$ Kg/ha.
	$N_3=N_4=N_{90}=90$ Kg/ha.
Year 2000-2001	I year
Year 2001-2002	II year

INTRODUCTION

INTRODUCTION

Barley (*Hordeum vulgare* L. *sansu lato*) is ~~the~~ an important *rabi* (winter) season cereal crop of India ranking next to wheat. It is the man's most ancient foodstuff. Being a poor man's crop it is grown basically in the agriculturally backward part of the country under the limited inputs and irrigation management. However, thick coating of the husk has reduced very badly its food value. Some modern scholars consider it the oldest of the cultivated plants. Barley is considered to be hardier than wheat and can sustain unfavourable agro-climatic conditions to a greater extent.

The nutritive value of barley is considerable, however, the deficiency in gluten makes it a poor breadstuff. Unleavened barley cakes, however, are a favourite food of the rural ~~classes~~ people. The husk is ground off, yielding pot barley and if more of the grain is ground, the familiar pearl barley results. This is much used for soups. The six-rowed kinds which have a higher protein content, are used for food purposes both for man and ~~for~~ animals.

Today the chief utilization of barley is a feeding stuff for livestock. About 20 to 25% of produce of the crop is used as a source of malt to be used for preparation of alcohol, whiskey, bear and similar beverages. For this purpose, the two-row types with a low protein content, a softer, mealy endosperm, and thin hull are preferable. The grains are also used for manufacturing pearl and powder products, which Repetition

generally form the diet of sick people. Surplus grain provides feed for cattle and horses. Barley straw is also fed to cattle.

In general, barley gives a cooling effect to the body and in olden days eating or drinking of barley as 'Sattu' or syrup was recommended for putting of the heat during months of summer. Barley water is recommended and has been found good for those who are suffering from diarrhoea, dysentery etc.

Malt syrup is also utilized for making candies, break fast cereals, medicines and in textile industry. The grains are also used for manufacturing plant and powder products, surplus grains provide feed for the cattle and horses etc. Barley basically consumed as a human food but it also supplies a valuable feed and industrial raw material. Repetition

In the advance nation like U.S.A. more than 50 per cent barley production is used for livestock feed, 30 per cent for malted produce and the rest is used as the food products. Barley grains contains 11.5% protein, 74% carbohydrate, 1.3% fat, 3.9% crude fiber, 1.5% ash and 1.2% minerals. In India, the most important use of barley is as grain feed to livestock and poultry, as malt for the manufacture of beer and other liquors like whisky, brandy etc. Grains are also broken and roughly ground in 'pearl' barley to be used in soup. Barley is best suited for fodder purpose because of its very vigorous plant growth. It may be grown exclusively for fodder purpose also. Now barley varieties are being

evolved which can be used for fodder-cum-feed grain production.

Among the released varieties, Ratna, K-125 and BG-25 are well suited for fodder cum feed grain production. New varieties like Karan-21, K-5 and K-10 have already been entered in the all India Co-ordinated fodder Research Project for evaluation at the national level.

In India, barley is widely grown in Uttar Pradesh, Rajasthan, Punjab, Himanchal Pradesh and Madhya Pradesh. The major share of production of barley comes from traditionally barley growing states like U.P. (31.5%) and Rajasthan (25.5%). The total area under barley cultivation in India is about 2.9 million hectares with the production of about 3.1 million tonnes of grain with the average yield of 1271 kg/ha.

Uttar Pradesh is one of the most important barely growing
which has cultivated area of
state of India cultivation is about 3.15 lakh hectares with the annual production of 6.35 lakh tonnes and productivity is about 20.19 quintal/hectare in 1998-99 and produced nearly half of India's total production with an area under and sharing about 44.02% and 48.09% to the total area and production in the country, respectively. In this way, U.P. has a great significance both in area and production of barley crop. The other barley growing states of country are Rajasthan (24.93), Haryana (8.2%), Punjab (7.9) and M.P. (5.09%).

Bundelkhand region is the main barley growing tracts of U.P.

Hamirpur district lies in Chitrakoot Dham region of U.P. with the total area under barley production upto 1837 hectares with the production of 3272 metric tonnes and productivity of 17.21 q/ha. It is grown in all districts of this region because, the irrigation facilities are ~~not~~ in adequate and about 75% area is comes under unirrigated. The farmers of this region grow winter season crops by use of water harvesting techniques and moisture conservation practices. On other hand, ~~the soils~~ MAR and PARWA soils of this region are lack in nutrients ~~stressed~~ and ~~therefore,~~ There soils are more thirsty than hungry due to lack of ~~sufficient~~ moisture during crop growth period, hence, There is limited choice of crop, ~~their~~ varieties and cropping pattern. ~~are followed~~. In those areas where the cultivation of wheat is difficult ~~for good production~~ the cultivation of barley is preferred by the farmers. In this region, the production and productivity of barley crop is very low due to lack of conclusive information about the appropriate sowing time and nitrogen levels for the newly developed improved varieties of barley.

The crucial factor while exploiting the full genetic potential of any crop variety, is based upon it's cultivation under various management practices including time of sowing and fertilizer levels. The response to fertility levels in respect of nitrogen nutrition differ to their morphological stature governed through genetic make up to accordingly. The proper understanding of physiological process at various stages of crop growth provide a guideline to decide the

Unnecessary repetition of the Sentences.

ideotype as well as optimum rate of physiological processes for high grain yield production based upon the various package of practices. Therefore, to quantify the physiological efficiency and capacity of genotype would be of great importance in practical management programme.

Optimum time of sowing plays an important role in enhancing the yield of crop. It is well known that barley varieties respond sharply for yield and other characters to climatic variations according to the time of sowing. Earlier studies conducted at Rewa, (M.P.) indicated that the barley variety RD 2035 sown on 31 October performed the best with respect to yield and net return (Kaurav, 1992). However, in case of wheat, 22nd November was found to be the most suitable date for maximum production (Singh, 1997). not relevant

The response to fertility levels with respect to nitrogen nutrition differs according to their morphological stature governed through genetic make up. The proper understanding of physiological processes at various stages of crop growth provides a guideline to decide the ideotype as well as optimum rate of physiological processes for higher grain production based upon the various package of practices. Therefore, quantification of physiological efficiency and capacity of genotype would be of great importance in practical management programme. Barley has given significant higher grain production over its competitive rabi season cereal

wheat under dryland conditions. If it is irrigated at critical stages of its growth, it can prove economically superior to wheat crop. The manifestations of yield-contributing components under different fertility levels particularly nitrogen in irrigated barley crops is a need to investigators considering their direct and indirect contribution towards grain production. Nitrogen is known as one of the primary (major) plant nutrients, It is an integral part of the chlorophyll and all proteins. Plants deficient in nitrogen are stunted and yellowish-green. The deficiency of nitrogen is almost universal in Indian soils. Generally soils analyzing less than 1% organic carbon or below 280 kg/ha oxidizable nitrogen are classified as deficient. ~~the crops grown will respond to nitrogen.~~

It is an established fact that an excess of nitrogen applied to barley crop, gets accumulated in grain and makes in unfit for malting purposes. Application of nitrogen has a direct effect on yield in most of the cereals including barley also. The ~~however,~~ time of sowing also influence the productivity of barley up to a greater ~~to more~~ extent. ~~also,~~ Therefore, present research work will provide the appropriate information regarding the balanced use of nitrogen and optimum time of sowing to get the desirable yield without increase in grain protein. Besides, due to rising demand for good quality malt, the development of ~~developing adaptable,~~ high yielding and good malting quality barley varieties assumes paramount importance. The malt quality improvement is not only expected to give a great fillup to the malting industry in India, but will

also result in upgradation of quality and productivity per unit area, thereby assuring more remunerative price to the barley cultivators.

Some of the well-promising (high-yielding) barley cultivars have been developed for the barley growers farmers of Bundelkhand region. For ~~such~~ these cultivars, the balanced nitrogen requirement and optimum sowing time is to be evaluated. The information on these aspects ~~are~~ is lacking for this tract. The present investigation was, therefore, carried out to generate information on the maximized production of high-yielding barley genotypes fertilized with different levels of nitrogen. The information on the varie~~tal~~y x sowing dat~~es~~e x nitrogen interaction will be useful to the barley growers of this region because proper nitrogen nutrition at optimum sowing time would mitigate hidden requirement of the new genotypes for this nutrient. Keeping in view the above mentioned facts, the present study was undertaken with the following objectives.

1. To ~~know~~ study the relative performance of new barley varieties under irrigated conditions in Bundelkhand region.

2. To determine the influence of nitrogen levels on production and malt quality traits of barley under irrigated conditions.

3. To find out the most suitable time for sowing under irrigated conditions of Bundelkhand.

4. To find out the most suitable combination of variety,

date of sowing and nitrogen level on growth, yield and quality of barley ~~for~~ under irrigated conditions in Bundelkhand region.

5. To work out the economics of the various ~~treatments~~ treatment combinations.

****

REVIEW OF LITERATURE

REVIEW OF LITERATURE

respect

The past work done in resect of dates of sowing and reaping of the crop is described as under:

2.1 Effect of dates of sowing :

Rao *et al.* (1979) conducted trial in which triple dwarf wheat (Hira) was sown between 5th November to 19th January giving 15 days(x)intervals and found that this variety possesses the potential of giving good yield 48.59 q/ha even when planted as late as 20th December. The reduction in grain yield due to 30 days delay was hardly 5 quintals. The variety planted as late as 19th January produced 28 q/ha.

Yadav and Sharma (1979) reported that in trial with 9 dwarf wheat cv. on 7 dates between 16th November and 20th January the pattern of N accumulation by plants at successive growth stages followed a significant trend. In general, N uptake was highest in crops sown in November and decreased with further delay in sowing. cv. UP 319 was the most deficient utilizer of nitrogen.

Knapp and Knapp (1980) in the study of effect of planting date and fertilizer in winter barley, found that very early and late planting significantly decreased the grain yield of barley.

Singh and Mishra (1980) observed in a study of relative yield potential of hulled (Jyoti) and hull-less (HBL 3) barley grain under grown different dates of sowing and fertiliser application that have given significantly higher yield (40 to 80 q/ha) as compared to hull-less barley HBL 3 (31 to 68 q/ha). Jyoti had also higher thousand grain weight and more number of grains per ear, while HBL 3 produced significantly higher number of ear bearing shoots and protein content. First fortnight of November proved to be the ideal time of sowing for both the types of barley.

Agrawal and Arora (1980) achieved significantly maximum yield of barley sown on first week of November, while they did not find response of barley to varying seed rates (100 kg and 125 kg/ha).

Singh (1982) conducted comparative study of barley and wheat and found that the yield of barley and wheat decreased significantly by 39.9 kg/ha/day from 15^{th} to 25^{th} November sowing dates, and 65.2 kg/ha/day from 25^{th} November to 25^{th} December sowing dates. Delay in sowing reduced the grain yield of barley by 41.4 kg/ha/day. The decrease in wheat yield was 48.9 kg/ha/ repetition day. The decrease in wheat yield was up to 48.9 kg/ha/day. Barley crop produced significantly higher grain yield over wheat under dry farming conditions.

Jaimini and Singh (1982) worked at R.A.K. College of Agriculture, Sehore (M.P.) and found that number of effective tillers ~~were~~ was influenced significantly by different dates of sowing. Crop sown on 5 November (D_1) produced more number of effective tillers followed by D_2 (20th November) and D_3 (5th December). They also stated that number of green leaves and plant population were not influenced by different dates of sowing.

What was the crop?

Kapur *el al.* (1982) conducted a field experiment at Fatehpur with three varieties (WL 711, HD 2009 and HD 2004), three dates of sowing (7th and 13th November and 15th December) and concluded that WL 711 produced significantly more yield than HD 2009 and HD 2004 when sown at 7th November. Delayed sowing resulted in decreased yield.

Raghuwanshi and Singh (1983) worked at Sehore (M.P.) and observed that the sowing of crop on 4th November recorded more number of tillers, height and leaves as compared to sowing on 4th December.

Which crop?

Singh *et al.* (1983), at Pantnagar, conducted a field experiment comparing five sowing dates (October 16, November 1, November 17, December 3 and December 19) and found that during 1976-77, the average grain and straw yields of wheat varieties decreased with delay in sowing after 1st November. The yield was significantly lower in 16th October sowing than in 1st November sowing.

Joshi and Singh (1983), at Udaipur, conducted an experiment with three dates (5 October, 5 November and 5 December) resulted in a 10.2 and 19.9 per cent decrease in grain yields over early (5 October) and late (5 December) than normal sowing.

Thakur and Juddev (1983) worked at Zonal Agricultural Research Station, Powarkheda (Hoshangabad), M.P. and conducted that the timely sowing gave significantly highest yield while early and late sowing were found equal.

Phadnawis and Saini (1986) worked at I.A.R.I., New Delhi and found that three wheat cultivars sown on nine different dates between 10^{th} October to 23^{rd} February at a density of 200 plants/m^2 gave the highest grain yield when sown on 29^{th} October. Contribution of the tillers to yield was highest in the early sown crop but decreased with a delay in sowing.

Bagga *et al.* (1987) conducted an experiment at I.A. R.I., New Delhi with wheat cultivars Hindi 62 and HD 2329 which were sown on 20^{th} October (early), 4^{th} November (normal) and 19^{th} November (late) and found that seedling establishment was reduced with early sowing.

Sarkar *et al.* (1987) conducted an experiment at Sambalpur (Orissa) in 1982-83 with 13 wheat varieties. Crops sown in early November, mid November or early December gave similar grain yield of 1.5 - 1.57 t/ha. Yield was highest (2.21 t/ha) in cultivar

HI 784 and lowest in U.P. 1008.

Patel *et al.* (1987) reported from South Gujrat that irrigated wheat grain yields decreased with a delay in sowing from 15th November to 30th November and 15th December.

Girothia *et al.* (1987) at J.N.K.V.V. College of Agriculture, Indore (M.P.) from a field experiment on medium black cotton soil during 1984-86 and concluded that normal sown wheat crop (15-20 November) recorded significantly more tillers, test weight and grain & straw yield from late sown crop.

Paradkar *et al.* (1987) worked at J.N.K.V.V. College of Agriculture, Rewa, (M.P.) with cultivars Sonalika sown on December 16, 23 AND 30 in 1981 and January 6, 1982. Delay in sowing dates decreased yields up to 2.8 t/ha when sown on December 16 to 1.9 t/ha when sown on January 6.

Choudhary *et al.* (1988) reported that the timely sown crop took the benefit of longer period available for its growth and development. The relatively longer period available from heading to maturity was very conducive to achieve higher yield.

Samere *et al.* (1989) worked at Ludhiana with eight varieties cultivated under ten dates of sowing (from October 15 to January 15 at the interval of 10 days) during 1982-84. Long duration wheat varieties WL 711 and PBU 12 performed better when sown

from 15 October to 5 November, whereas, the short duration varieties (PBU 54, Sonalika, SKML 1 and HD 2285) were adversely affected by early sowing and performed better when sown on 5 November. The durum wheat varieties (PBU 34 and DWL 5023) produced the highest yield when sown on 15 October.

Sharma and Chakor (1989) worked at Palampur revealed that planting in ~~at~~ first week of November produced significantly more effective tillers and plant height than planting at first week of December and January. crop

Vitkare *et al.* (1990) found at Kanpur that 30th November sowing gave the highest yield of wheat (33.28 q/ha) as compared to 27.50 q/ha on 15th December sowing and 20.54 q/ha on 30th December sowing dates. The decrease in the yield due to delayed sowing may be attributed to short growing period available to crop for its growth and development, particularly,the development of grain as indicated 1000-grain weight and grain yield/plant. The decrease in the yield by early sowing might ~~be due~~ to high temperature during late October early November which ultimately resulted in poor germination and seedling establishment. not clear Similarly high temperature in late March and early April interfered with the normal development of the grain causing grain shrivelling in the latter sowing dates. They further indicated that decrease in the yield due to delayed sowing may be attributed to short growing

period available to crop for its growth and development, particularly the development of grain as affected by 1000-grain weight and grain yield/plant.

Parmar and Singh (1990) worked at R.A.K. College of Agriculture, Sehore (M.P.) and found non-significant effect on number of plant per metre row length. They also stated that plant height, number of leaves and number of tillers were maximum in 45th meteorological week's sowing. Crop

Pandey and Agrawal (1991) experimented at Pura, Kanpur (U.P.) reported that the effect of delay in sowing (15 days after normal) was adverse as compared to sowing on 1st November. Crop

Porwal *et al.* (1991) reported that the grain yield of barley was maximum when sown on 15th November, followed by 30th December. The increase in the grain yield was associated with ear length and 1000-grain weight. The results conform the findings of Rao and Wattal (1986). Barley varieties did not differ significantly for ear bearing tillers/m row (except 1985-86), ear-length and 1000-grain weight. Rao and Wattal (1986) also opined that ears/m^2 and grains/ear of various varieties did not differ. RD 57 and RD 31 gave significantly higher grain yield than RD 221 and RD 137.

Naik *et al.* (1991) experimented at Sardar Krishinagar and found that date of sowing significantly influenced the plant height.

Among sowing of 31st October, 18 November and 15 December, medium sowing produced significantly taller plants.

Sarkar and Torfdar (1992) revealed that wheat sown on 20th November gave significantly higher grain yield (1.795 kg/ha) than the other sowing dates which was mainly due to longer spike, more number of grains/spike and appreciable time available for flowering and maturity compared with early and late sowings.

Kaurav (1992) found at Rewa that the barley variety R D 2035 sown on 31st October performed the best producing 35.03 q/ha grain with the net-return up to Rs 15793/ha.

Jain *et al.* (1992) conducted experiment with five dates of sowing (20 December, 29 December, 9 January, 19 January and 29 January) and with six varieties (Lok 1, HD 1553, HI 784, J 405, WH 147 and HI 1213) of wheat and reported that late sowing significantly reduced grain yield in all the varieties by 4.17, 22.30, 39.71 and 56.62 % with delay in sowing by 10, 20, 30 and 40 days compared with crop sown on 20th December.

Singh *et al.* (1992) reported that 8 November sowing resulted insignificant increase in the growth, yield-attributes and yield of wheat (WH 283) at Hissar. Sowing of wheat beyond November 28 resulted in a significant decrease in grain yield. Delay in sowing from November 8 to November 28, December 21 and January 8 resulted in grain yield loss by 6.12, 13.01 and 29.13 percent,

respectively.

Behera (1994) found that the highest grain yield 41.1 q/ha was obtained by sowing wheat on 17th November. Number of effective tillers/m row length and test weight also followed similar trend, indicating that these two parameters were jointly responsible for highest yield in crop sown on 17th November.

Ahuja *et* al. (1996) reported that the grain yield of wheat was significantly influenced due to different dates of sowing. The yield recorded with normal date of sowing was significantly higher (12 q/ha) to those with late sowing dates.

Singh (1997) found at Rewa (M.P.) that the sowing of wheat crop on 22nd November gave a good yield up to 46.28 q/ha for agroclimatic conditions of Kymore plateau.

Sen (1999) conducted experiment at Rewa, (M.P.) and found that sowing of barley on 21 November gave a good yield upto 40.46 q/ha and the variety RD 2552 gave higher yield of 37.80 q/ha and was found suitable for the irrigated areas of Kymore plateau. The second best variety was RD 2559 yielding 35.70 q/ha. Thus, the best combination was 21 November and RD 2552 giving higher net return upto Rs. 18980/ha.

2.2 Performance of improved varieties of barley

Barley till now has been treated as a coarse grain because

of association of husk character with grain . Therefore, attempts have been made to improve the grain quality of barley by developing hull-less amber grain cultivars. The grains of these cultivars are amber in colour, bold and soft to hard in texture. In chapati making quality hull-less barley is as good as wheat. Now-a-days hundreds of high-yielding semi-dwarf lines have been developed. Some of these have high degree of adaptability to rainfed dryland and saline-alkaline soil conditions.

Scientific improvement work in barley was initiated in the early part of the present century. However, systematic and more intensive efforts were made only after the formation of multi-disciplinary All India Co-ordinated Barley Improvement Project during 1967-68. During the last decade, a dozen of improved barley varieties with better built in agronomic attributes and tolerance to major diseases (rusts etc.) and pests (aphid etc.) were developed and released for cultivation. The important ones are Kailash, Himani, Domla and BHS 46 for the hills; Ratna, Jyoti, DL 70, DL 36, DL 85, P 103, DL 171, P 267 and RS 6 for irrigated and Ratna, DL 3, DL 157, Vijaya, PL 56, Azad, BG 25 for rainfed North Indian plains. The variety DL 88 had proved to be an outstanding variety for the late sown condition. In coastal saline areas of Eastern India, DL 120, Azad, Amber, Jyoti, K 169 have done very well, while in *diaralands* of Eastern U.P. and Bihar, K 141, DL 85, DL 88 and P 147 have given very high yields.

Singh *et al.* (1971) and Biswas and Singh (1982) found that yield of some of the semi-dwarf varieties (BM 21, DL 70, RBD 1 and DL 85) was more around 4-5 tonnes/ha than the tall ones (3.4 tonnes/ha).

Krishnamurthi *et al.* (1972) observed in a barley trial of eighteen varieties that BHD 29, BG 1, HP 104 and NP 113 were better adopted to red sandy soils.

Gasper (1973) in a field trial of fifteen barley cultivars conducted during 1969-71 reported the average yield of 25.9-34.9 q/ha. The highest yielding variety was 62-104 followed by Perfect. The highest thousand grain weight (42.1 g) was given by Quantum cultivar. Proctor was found to have highest harvest index (64.5).

Ikonomi (1973) studied the morphological and agronomical characteristics of eighteen important barley cultivars in Albania and reported that Korea was the best productive cultivars having resistance to rust and low temperature.

Singh (1974) indicated that for malting and brewing, 2-row barleys were preferred over 6-row barleys "Clipper" and Australian 2- row barley was recommended in certain tracts of North-Western India for malting and brewing based on its superior malting quality and grain yielding performance.

Misra (1976) studied the effect of N levels on yield and yield components of four varieties and reported non-significant differences for grain yield, straw yield, plant height, tillers per plant and thousand grain weight.

reported that

Singh and Mishra (1976) barley varieties DL 3, RD 31, Vijay and Ratna were found to be equally suitable.

Verma *et al.* (1977) found that the varietal differences with respect to all the characters were significant. Variety Karan 280 was the highest yielder followed by Karan 15.. Among the hulled and hull-less barley varieties Karan 280 and Karan 231 respectively were the outstanding one. Prasad *et al.* (1983) also reported similar results.

Singh *et al.* (1978) studied the relative performance of two-row barley cultivars at different seeding and nitrogen rates in North India plains and reported that two-row cultivars Clipper performed better in North Western plain zone, while DL 102 in North Eastern plain zone.

Jana *et al.* (1978) reported the highest yield of 14.8, 13.7 and 11.7 q/ha with varieties Ratna, RS 6 and DL 150, respectively under agronomic conditions of West Bengal. They also reported that two-row cuitivar DL 150 was twenty days earlier in maturity than other two-row cultivars and one week earlier than six-row cultivars.

Khatua and Sumal (1978) reported non-significant differences in grain yield of barley cultivars DL 3, Ratna, Vijay and K 125 under rainfed condition.

Varshney (1979) observed the highest yield in barley cultivar Ratna (37.09 q/ha) and lowest in cultivar K 125 (29.49 q/ha). However yield differences were ~~was~~ statistically non-significant.

Singh *et al.* (1979) studied the yield potential of four six-row barley cultivars under varying levels of N in a sandy-loam soil during 1975-76 and 1976-77. They reported that DL 120 gave the highest yield of 25.8 q/ha in 1975-76 and Jyoti gave the highest yield of 17.1 q/ha in 1976 in twenty two trials with winter barley cultivars at six locations.

Barley, in general, proved highly tolerant to saline irrigation water (salt content up to 15000 ppm). Variety Vijaya did very well in soils (pH 9.0) of Karnal (CSSRI, 1979).

Rusmusson (1979) reported that the grain yield of two-row cultivar namely Igri, Sanja and Hydra were 59.7, 56.6 and 52.6 q/ha, respectively. The average yield of six-row cultivars *viz.*, Cerbel, Mamut, Bright, Mirra, Banteg and Kiruna was 62.2, 58.8, 57.7, 57,6, 55.9 and 54.5 q/ha respectively.

Mahabalram (1979) reported that hulled-barley varieties Karan 15 showed wider adaptability to irrigated, rainfed, late-

sown, saline and diaraland conditions. He also reported that Karan 6 and Karan 92 have shown better performance under irrigated, timely sown, late-sown and under rainfed conditions.

According to Tiwana and Puri (1980). barley varieties C 164, Ratna, Azad and PL 56 have shown high green fodder yield potential comparable to that of oats. Barley tillers more profusely than oats. The grain yield potential after the harvest of green fodder (60-70 days after sowing) in barley has been found to be as high as or slightly better than that of oats. The highest yield of barley cultivar BH 25, BG 105 and BG 164 has been reported by Agrawal and Arora (1980).

A result of barley trial conducted at twenty three locations in twenty one countries revealed that average grain yield ranged from 25.3 to 31.1 q/ha which was highest for barley cultivars Pro-GUA x DL 70 and Conquest (Anonymous, 1980).

Singh and Misra (1980) reported that intensive efforts are the steps to develop suitable high-yielding hull-less varieties, good performance of BHI 3, Karan 16, Karan 18 and Karan 19 in yield and IB 65 in grain appearance in the plains.

not related

Singh and Sandhu (1981) pointed out that barley is generally grown on marginal and sub-marginal lands and it performs well under late-sown conditions both in irrigated and rainfed areas.

Jha and Moorthy (1981) reported that barley could be a potential winter crop in rainfed upland areas of Orissa after harvest of paddy. They also observed the highest yield of barley cultivars K 247 (17.3 q/ha) followed by K 252 (15.9 q/ha), K 273 (15.5 q/ha), K 267 (14.4 q/ha) and P 362 (13.6 q/ha). Barley cultivar DL 263 gave the lowest grain yield of 8.7 q/ha.

Chillar and Dargan (1981) found that the barley variety Vijaya being at par with Jyoti gave significantly higher grain yield than C 164 and Ratna. The difference between Jyoti and Ratna was, however, not marked. Vijay gave 22 per cent highest yield than C 164 and 15 per cent higher yield than Ratna,

Jha *et al.* (1981) worked on different varieties of barley on alluvium sandy soil (pH 6.8) and found that there was no significant difference in yield among the varieties viz., K 141, P 302, K 169, K 125 and Ratna, the yield range being 20.8 to 23.2 q/ha.

Singh (1982) expressed the fact that wheat genotypes Sonalika and P 195 gave higher seed yield of 28.7% and 37.8 % over HD 2009, respectively. The differences in barley genotypes were still large. Clipper gave 58.9 % and 59.2 % less yield as compared to Jyoti and BH 105. Grain productivity in terms of kg/day/ha was 32.6 for BH 105, 20 for Clipper and 31.9 for Jyoti. The differences were due to genetic potentialities of the varieties.

Singh (1982) found that the varieties differed significantly with respect to grain yield and yield-attributes like shoot number/ m^2, number of spikes/m^2, spike-length and number of spikelets/ spike. BHS 46 outyielded other varieties significantly followed by HBL 175, mainly due to larger sized spikes and more number of spikelets/spike.

Singh and Prakash (1982) indicated that highest seed yield of 30.26 q/ha was received from barley variety DL 3 followed by DL 157 (24.76 q/ha), DL 120 (19.36 q/ha) and DL 192 (18.03q/ ha).

Results of the barley trial conducted under All India Co-ordinated Barley Improvement Project (Anonymous, 1982) revealed that Karan 15 was the widely adopted variety under moderately low input irrigated conditions of North-Eastern, North-Western and Central zone. It also gave the highest yield under late sown conditions of North-Eastern and North-western plain zone. The hull-less barley variety Karan 4 gave the highest yield of 31.7 q/ ha followed by Karan 3 (28.5 q/ha) under rainfed conditions of North-Western plain zone. Whereas Karan 3 gave the highest yield of 18.4 q/ha followed by Karan 16 (18.40 q/ha) and Karan 4 (17.91/q/ha) under rainfed conditions of North-Eastern plain zone.

Singh *et al.* (1984) found that the varietal differences with respect to all the characters under study were significant. The

variety Karan 280 was the highest yielder followed by Karan 15. The yield differences of these varieties were significant and both of them were superior to rest of the varieties. Among the hulled and hull-less barley, Karan 280 and Karan 231, respectively were the outstanding ones. These results agree with the findings of Prasad *et al.* (1983).

Singh *et al.* (1985) indicated that varieties did not differ significantly with respect to tillers/m row length. DL 85 gave significantly higher grain yield (40 q/ha) than that of P 267, PL 101, DL 165 and Jyoti, DL 165 outyielded Jyoti significantly. The highest grain yield (40.4 q/ha) recorded by DL 85 may be because of higher tillering capacity.

Raikwar and Paradkar (1987) conducted experiment at Rewa (M.P.) under dryland conditions with seven hulled barley cultivars (DL 85, DL 70, DL 157, RS 6, RD 57, RD 137 and Karan 15) and three hull-less cultivars (Karan 4, Karan 18 and Karan 16). Among these cultivars, DL 157 recorded significantly higher grain yield over the other cultivars. The higher yield of this cultivar was attributed to more grains/earhead coupled with bolder grain. The cultivars next in the order were DL 50, Karan 15, RD 57, DL 85, RD 137 and RS 6. All these cultivars produced identical yields.

Dwivedi *et al.* (1987) from Azamgarh (U.P.) reported that the varieties of barley differed significantly from each other in grain yield

and were in the following order, DL69, Ratna, K 71 and RD 102. The increase in yield was due to higher number of effective tillers, greater ear length and higher number of grain/ear among the varieties.

Raghuwanshi *et al.* (1987) reported that barley cv. DL 157 had significantly higher number of tillers and earhead/plant and recorded the maximum grain yield of 18.78 and 18.11 q/ha in 1983 and 1984, respectively.

Verma and Singh (1989) conducted experiments on malt-barley (*Hordeum distichum* L.) at Bichpuri, Agra (U.P.) and found that the variety Jyoti outyielded significantly over all the 2-row varieties in grain production. The next best variety in this respect was Clipper. But the difference in between Clipper and BHL 102 showed the linear relationship between the grain yield and levels of nitrogen. However, the yield of grain and total dry matter produce ~~were~~ was not influenced significantly by the two varieties.

On three years average, it has been observed (Anonymous, 1989-90) that Karan 741 was top yielder giving an average yield of 16.93 q/ha closely followed by Karan (15.55 q/ha).

Dahama (1991) found that barley varieties differed significantly for 1000-grain weight and grain yield. Grains of RD 31 and RD 57 were bold and resulted in significantly higher 1000-grain weight than that of RD 137. During 1983-84, 32and 34% higher grain

yield was recorded in RD 31 and RD 57 than in RD 137, whereas during 1984-85, the difference in the yield been narrowed down to 26 and 29 % respectively. These results confirm the findings of Singh *et al.* (1981).

Singh and Singh (1991) found out the effect of nitrogen and phosphorus on the yield, yield attributes and quality of hulled and hull-less barley (*Hordeum vulgare*) on a sandy-loam soil of low to medium fertility at Kanpur. 'Karan' (hulled) gave Significantly higher grain yield than 'Karan 18' (hull-less). Further, it responded significantly up to 60 kg N/ha and 30 kg P_2O_5/ha, increasing levels of nitrogen considerably.

Kumar and Agrawal (1991) studied the effect of irrigation and nitrogen on grain yield of huskless varieties (Karan 4 and Karan 16) of barley. Both these varieties were at par for grain yield significantly ~~over~~ under no irrigation and irrigation treatments.

Sharma and Chakravarty (1992) reported that grain development and the grain yield is a function of the photosynthetically active radiation intercepted. Rate of grain-filling varied even within the same plant type. Some varieties could not utilize the absorbed radiant energy to full extent, whereas some varieties which intercepted relatively lower energy showed higher grain-filling rate, indicating superiority in their ability to translocate maximum photosynthates to the sink. The plots belonging to the semi-

spreading type showed relatively stable performance with less variation in the grain development as well as grain. The varieties which recorded the lowest grain yield ('Karan 163', 'DL 85' and '234-21-13-7-32') as well as the grain weight/ear belong to high-interception group. This indicates that it is the individual varieties translocation ability of photosynthates from the source to sink that appears more promising feature compared to the amount of radiation intercepted.

Singh (1993) found that the barley varieties were differed significantly for yield-attributes and seed yield. RD 251 gave significantly ~~the~~ highest grain yield (39.85 q/ha), ~~being~~ which was 9.08. 14.21 and 17.89 % higher than that of RD 2035. BL 2 and RD 103, respectively. Higher values of ear-bearing tillers/m row (73.), ear length (7.30) and 1000 seed weight (53.24) than that of the other cultivars. The harvest index of RD 2052 was also highest, though remained at par with that of RD 2035 and BL2.

Awasthi and Suraj Bhan (1993) showed higher grain yield-attributes and yield of Lakhan barley than Vijaya, K 169, K 125 and K 141. Best performance of variety Lakhan may be attributed to its better survival under moisture-scarce condition and its ability to withstand moisture-stress condition.

Awasthi *et al.* (1993) found that wheat variety K 78 showed better root development (except root-depth) higher moisture extraction,

yield and moisture use efficiency than the other varieties. In barley, best development of roots in respect of depth, number of primary roots, moisture use, yield and moisture-use efficiency was observed in variety 'Lakhan'.

According to Sood *et al.* (1993), the barley varieties were differed significantly in their plant height, plants/m row length, green and dry fodder and crude protein yields. Dolma variety gave significantly higher green and dry fodder and crude protein yields than Karan 92 and Karan 2. The higher fodder yield in Dolma may be attributed to more plant height as well as more plants per unit area than Karan 92 and Karan 2.

Verma *et al.* (1993) assessed the genetic variability of 18 indigenous barley varieties. Characters like number of grain per ear and 1000 grain weight exhibited higher genotypic as well as phenotypic variances. The high values of GCV and PCV were observed for grain yield per plant,...indicating a good deal of genetic variability in this character in barley. Thus, direct selection for this trait would be highly effective in barley. High magnitude of heritability alongwith higher genetic advance was recorded for number of grains per ear and 1000-grain weight. Similar to these findings, wider range of genotypic and phenotypic variances have also been reported in barley by Dixit (1973), Ibrahim *et. al.* (1974) and Patni (1983).

Patel and Namdeo (1996) at Sidhi (M.P.) reported that the huskless varieties of barley (Karan 4 and Karan 741) produced extra grain yield of 5.51 and 5.56 q/ha and extra net-income of Rs 3484 to Rs 3523/ha over the local variety. The improved varieties recorded higher seed protein over the local variety.

Tomar (1998) found at Rewa (M.P.) that among the new barley varieties, PL 508 stood the best producing 43.0 q/ha grain with maximum net-return up to Rs. 20133/ha. This was closely followed by RD 2552 (Rs. 19,947/ha) and RD 2551 (Rs. 19,059/ha).

Baishander (2002) found at Rewa (M.P.) that among the malt barley genotypes, RD 2606 performed the best, producing maximum grain 40.87 q/ha and net return upto Rs. 20,630/ha. This was closely followed by RD 2503.

2.3 Effect of nitrogen on growth and yield of barley :

Barley is a crop of marginal and submarginal lands. The necessity of applying fertilizer to barley was duely realised during sixties and thereafter consorted efforts were made to find out the fertilizer response of this crop. Many workers (Chaudhary *et al.*, 1971; Singh and Prasad, 1972 and Singh *et al.*, 1972) have already found that rainfed as well as irrigated barley needs fertilizer application particularly nitrogen.

According to Mehta and Sekhawat (1970), barley is known to respond very favourable to the application of nitrogen. The optimum dose of nitrogen lies between 40 to 80 kg/ha as many workers had reported on the response of barley to graded levels of nitrogen under irrigated condition in different parts of the country.

Many workers (Seth and Prasad, 1971; Singh, 1974; Gupta *et al.* 1976; Hooda and Kalra, 1978) have observed that the average yield of N-treated fields was ranged from 1.5 to 2.5 t/ha whereas, unfertilized ones gave 0.8 to 1.0 t/ha.

Seth and Prasad (1971) reported that high level of conserved soil moisture and good winter showers pushed N-response to a level from 40-60 kg/ha and P-response was also recorded. The low dose of 20 kg N/ha applied partially through soil and partially through foliage gave significantly higher yield over to all N applied at sowing time. It was easier and more profitable to place entire dose of N, P and K at the time of sowing at a depth of 8-10 cm under the surface as compared to its split application.

Chaudhary *et al.* (1971) recorded heavier nitrogen response upto 100 kg/ha in barley, but significant response to phosphorus was obtained only at higher levels of N-supply.

Singh (1974) found that varieties x nitrogen interaction was non-significant though some of the semi-dwarf varieties like BM

21, DL 85, DL 70 responded to 60 to 80 kg N/ha at certain locations (Singh, 1975). Nitrogen response was positively correlated with N-uptake, which in turn was positively correlated with nitrogen-reductase (NR) activity in the plants, N-R activity increased in barley (DL 70 Jyoti) upto 45-60 days after sowing, while in wheat it continued up to 75-90 days and afterward declined. Tall barley (Jyoti) responded up to 40 kg N/ha, dwarf barley (DL 70) up to 80 kg N/ha and dwarf wheat up to 120 kg N/ha.

Sharma and Sharma (1976) reported that the ear-length and effective tillers/plant were the main factors influencing the grain yield. The recommended dose of N should be applied in splits (50% at sowing and 50% at first irrigation). Split application of N produced more ear-bearing tillers and grains per ear, 1000-grain weight and protein content in grain as compared to its single application all at sowing.

Singh and Mishra (1976) found that barley varieties DL 3, RD 31, Vijay and Ratna were found to be equally suitable for rainfed areas. Varieties responded up to 20 kg N/ha in first season and 60 kg/ha in the second season.

Ojha *et al.* (1976) and Roy *et al.* (1977) found that late sown irrigated barley responded significantly up to 60 kg N/ha. The yield of late barley ranged between 3.0 to 3.5 t/ha, whereas no nitrogen gave only 1.0-1.2 t/ha. Similarly, Singh *et al.* (1978)

also fund that irrigated barley responded significantly to 40-60 kg N/ha.

Hooda and Kalra (1979) reported that optimum dose of N for barley varied from 73 to 80 kg/ha under irrigated conditions. However, according to some workers (Singh and Parshad, 1972; Singh and Mishra, 1976; Jain and Jain, 1979) found that the yield of irrigated barley responded to 40 to 60 kg N/ha.

Singh and Mishra (1980) indicated that nitrogen need of this crop was higher (60-80 kg N/ha) than the hulled barley (40-60 kg N/ha). Barley when grown for green fodder responded significantly upto 90 kg N/ha.

Chillar and Dargan (1981) indicated that nitrogen up to 120 kg/ha increased the grain yield of irrigated barley significantly over control. The variety Vijay being at par with Jyoti which gave significantly higher grain yield than C 164 and Ratna. The results were in close conformity with those of Ojha *et al.* (1976).

Jha *et al.*(1981) reported that barley varieties did not differ significantly with respect to their yield. Crop responded significantly with nitrogen up to 60 kg/ha. The yield was double at 60 kg N/ha over no nitrogen.

Bhargava *et al.* (1982) showed that barley responded to 75 kg N/ha and half N drilled at sowing and half N top-dressed at

second irrigation gave the highest yield.

Biswas and Singh (1982) observed that Jyoti responded significantly up to 40 kg N/ha, whereas DL 70 and Arjun responded up to 80 kg N/ha. Grain yield was found to be positively correlated with N uptake and NR (nitrogen-reductase) activity. Arjun and DL 70 were superior to Jyoti in grain and protein yield. Protein yield was positively correlated with N-uptake and NR activity.

According to Mishra *et al.* (1982) barley has similar regenerating capacity after taking first cut of fodder like oats. At 25 kg N/ha, straw production of both the crops did not differ significantly. whereas oats gave significantly higher straw yields at both 50 and 75 kg N/ha. Grain production from the regenerated shoots in case of barley was significantly higher than that in oats. Straw yield was significantly increased with increase in level of nitrogen up to 75 kg N/ha in both the crops.

Menon and Shrivastava (1984) reported that mixtalol is able to increase plant growth and yield by way of influencing photosynthesis, cell-division and root growth. It acts only at moderate fertilizer application.

Singh *et al.* (1984) found that grain and straw yield of barley varieties increased significantly due to N and P levels. Application of 40 kg N/ha alone resulted in 5.3 q/ha increase in grain yield

and 6.0 q/ha of straw yield over no nitrogen. When 40 kg N/ha was coupled with 20 kg P_2O_5, the grain and straw yields increased further by 2.5 and 3.4 q/ha, respectively. Similar results were also reported by Verma *et al.* (1977).

Singh *et al.* (1985) observed significantly higher grain yield of barley with 60 kg N/ha over control and 20 kg N/ha. Nitrogen at 40 kg/ha was also significantly superior to 20 kg N/ha. Nitrogen at 60 kg/ha. increased yield over 0, 20 and 40 kg N/ha by 33.9. 16.7 and 1.0%, respectively. Similar results were also reported by Singh *et al.* (1983) and Prasad *et al.* (1983).

Dwivedi *et al.* (1987) reported that the grain yield and yield attributes of barley varieties were increased with N levels up to 80 kg/ha. The straw yield increased markedly in linear fashion up to 80 kg N/ha.

Shekhawat *et al.* (1989) obtained maximum grain yield of barley when the non-grain parts of preceding clusterbean were turned into the soil, after removing the grains, with an application of 60 kg N/ha. Barley grown after a full crop of clusterbean gave 9.0 and 10.0 q/ha more grain and straw, respectively over the barley grown after pearlmillet. Application of 60 kg/ha increased grain yield by 2.34 and 6.74 q/ha over 40 and 20 kg N/ha respectively.

According to Mishra *et al.* (1991), the highest grain yield was recorded at 120 kg N/ha being at par with 80 kg N/ha. Moisture extraction and consumptive use of water increased with increasing levels of N up to 120 kg/ha. Moisture use efficiency was the highest at 80 kg N/ha but reduced at 120 kg N/ha. Increasing levels of N also increased the moisture use from deeper layers. Adinarayana and Tewari (1987) also found similar results.

Porwal *et al.* (1991) reported that the increase in the grain yield of barley was associated with ear-length and 1000-grain weight. The results conform the findings of Rao and Wattal (1986), but contradicts from those of Bonclirelli (1989). Barley varieties did not differ significantly or ear-bearing tillers/m row, ear-length and 1000 grain weight. Rao and Wattal (1986) also opined that ears/m^2 and grains/ear of various varieties did not differ. RD 57 and RD 31 gave significantly higher grain yield than RD 221 and RD 137.

Awasthi and Suraj Bhan (1993) found that 60 kg N/ha increased significantly plant height, leaf area index, dry-matter production, spiekes/m^2, grains/ear, 1000-grain weight and harvest index. These characters in turn resulted in the highest grain and straw yields over other levels of N. Improved growth and yield-attributes increased with the increasing doses of N. may be due to the fact that N being an important constituent of nucleotides,

proteins, chlorohyll and enzymes, involves in various metabolic process which has a direct impact on the vegetative and reproductive phases of plants. At the low level of N, plant might have not been able to meet N requirement ultimately resulting in stunted growth. At higher level of N, crop absorbed sufficient amount of N, resulting in better growth parameters which in turn gave higher grain and straw yield. These findings are in accordance with those of Jha *et al.* (1981).

Soils in the arid and semi-arid regions do not contain much organic matter, and it is likely that N is the major nutrient which limits maximum barley yield (Jaradat and Haddad, 1994).

2.4 Response of barley genotypes to N levels.

Different workers (Chaudhary *et al.* 1971; Singh and Prasad 1972 and Singh *et al.*, 1972) observed that rainfed as well as irrigated barley needs fertilizer application particularly nitrogen.

Singh and Mishra (1976) found that barley varieties DL 3, RD 31, Vijay and Ratna were equally suitable. The varieties responded upto 20 kg N/ha in first season, and up to 60 kg N/ ha in the second season

According to Singh (1982) BHS 46 outyielded other varieties significantly followed by HBL 175. This may be due to larger sized spikes ad more number of spikelets/spike. Increase in each unit

of N increased the grain yield and yield-attributes significantly. There was 35. 129 and 117% increase in barley yield over control due to 20, 40 anc 60 kg N/ha. HBL 87 and BHL 175 responded significantly upto 40 kg N/ha. While response of Dholma was up to 60 kg N/ha, probably due to its high-tillering capacity which was reflected in number of shoots/m^2.

Singh and Prakash (1982) observed that highest seed yield was received from barley DL 3, followed by DL 157 DL 120 and DL 192. Barley DL 3 gave the highest seed yield at 60 kg N/ ha The DL 157, DL 192 and DL 120 gave maximum seed yield at 20. 40 and 40 kg N/ha. respectively.

Singh *et al.* (1984) found that application of 40 kg N/ha alone resulted in 5.3 q/ha increase in grain yield and 6.0 q/ha of straw yield over control. When 40 kg N/ha coupled with 20 kg P_2O_5/ha, the grain and straw yields further increased by 2.5 and 3.4 q/ha, respectively.

not related to main heading

The same trend was observed in plant height, effective tillers, ear length and 1000-grain weight. Similar results were also reported by Verma *et al.* (1977). The variety Karan 280 was the highest grain yielder, followed by Karan 15. The yield differences in these varieties were significant, and both of them were superior to rest of the varieties. Among the hulled and hull-less barley, Karan 280 and Karan 231 respectively were the outstanding ones.

These results agree with the findings of Prasad *et al.* (1983).

Raghuwanshi *et al.* (1987) reported that barley cv. DL 157 had significantly higher number of tillers and ear heads/plant and the maximum grain yield. Increasing levels of N up to 80 kg/ha significantly increased the growth and yield of barley. The yield obtained in cultivars DL 157 and DL 3 with 80 kg N/ha were statistically at par, except the yield obtained through DL 120 in 1984 and at 80 kg N/ha. DL 157 was the highest yielder.

According to Dahama (1991), the barley varieties varied significantly for 1000-grain weight and grain yield. Grains of RD 31 and RD 57 were bold and resulted in significantly higher 1000-grain weight than that of RD 137. Nitrogen did not influence the yield-attributes except ears/m^2 and ear length. Ears/m row length showed corresponding increase with each increment in N level, and the significant difference was recorded only between 60 kg N/ha and the control. Similarly, 60 kg N/ha resulted in significantly longer ears as compared with no nitrogen. The interaction effects of barley varieties and N levels were not significant, indicating that the varieties showed similar response to N fertilization. These results confirm the findings of Singh *et al.* (1981).

Kumar and Agrawal (1991) found that the huskless varieties (Karan 4 and Karan 16) of barley were at par for grain yield. The average grain yield increase was 1.31 - 3.42 t/ha with 60

kg N/ha as compared with no nitrogen. The response to applied-N was higher in irrigation than in no irrigation treatment. The per cent recovery of applied-N decreased with an increase in N level. The production efficiency was maximum with 20 kg N/ha and decreased with an increase in N dose.

Singh (1993) reported that the ear-bearing tillers, ear-length and grains per ear were significantly higher at 80 kg N/ha than at 60 kg N/ha. Increases in these yield-attributes resulted in significant rise in grain yield and harvest index (HI) by 13.88 and 4.97%, respectively at 80 kg N over 60 kg N/ha. Barley varieties differed significantly for yield-attributes and seed yield. RD 2052 gave significantly the highest grain yield (39.85 q/ha), being 9.08, 14.21 and 17.89% higher than that of RD 2035, BL 2 and RD 103, respectively. Higher yield of RD 2052 could be attributed to higher values of ear-bearing tillers/m row, ear-length and 1000-seed weight than that of the other cultivars. The HI of RD 2052 was also highest, though remained at par with that of RD 2035 and BL 2.

Awasthi and Suraj Bhan (1993) showed higher growth, yield-attributes and yield of "Lakhan" barley and "Vijaya", K 169, K 125 and K 141. Increase in the level of nitrogen affected the plant growth development, yield-attributes and yield. Nitrogen @ 60 kg ha gave the maximum yield of barley. Best performance of variety

"Lakhan" may be attributed to its better survival under moisture-scarce condition and its ability to withstand moisture-stress condition.

According to Awasthi *et al.* (1993), the wheat variety "K 78" showed better root development (except root-depth) higher moisture extraction, yield and moisture use efficiency than the other varieties. In barley, best development of roots in respect of depth, number of primary roots, moisture use, yield and moisture-use (MUE) was obtained in "Lakhan" variety. Nitrogen @ 60 kg/ha efficiency resulted in the maximum root-expansion, moisture use and MUE and yield of wheat and barley over to that obtained with 0.20 and 40 kg N/ha.

Sood *et al.* (1993) found that the barley varieties differed significantly in their plant height, plants/m row length, green and dry fodder and crude protein yields. Dolma variety gave significantly higher green and dry fodder and crude protein yields than Karan 92 and Karan 2. Nitrogen levels also encouraged all these characters and grain yield significantly. The green-fodder and dry-matter yields increased consistently and significantly up to 40 kg N/ha. Taneja *et al.* (1981) also reported a linear response of forage yields of barley up to 120 kg N/ha.

According to Patel and Namdeo (1996), the huskless varieties of barley (Karan 4 and Karan 741) produced extra grain yield of 5.51 and 5.56 q/ha and extra net-income of Rs. 3484 to Rs. 3523/

ha over the local variety. The improved varieties recorded higher seed protein over the local variety. Application of N 60 kg/ha proved beneficial towards the yield and yield-attributes of barley varieties.

Chakrawarty (1999) found that new barley genotype RD 2552 stood the best for Rewa region of M.P., closely followed by RD 2559 and RD 2503 application of 80 kg N/ha produced significantly highest grain of new barley genotypes. Genotype X nitrogen interaction was non-significant.

Patel *et al.* (2000) reported that the barley genotype RD 2508 proved the best for agro-climatic conditions of Rewa region (M.P.). This was followed by K-565 and DL 88. The highest grain yield of barley genotypes was recorded with 60 kg N/ha, significantly superior to the lower levels. Genotype x nitrogen interaction was non-significant.

Tomar *et al.* (2001) found that RD 2552 performed the best for Rewa region of M.P. This was closely followed by RD 2553. Grain yield and net return of barley genotypes were maximum at 80 kg N/ha. The genotype x nitrogen interaction was found significant only in first year. RD 2552 with 80 kg N/ha proved the most profitable.

Pandey and Singh (2001) revealed that grain and straw yields and content and uptake of N and P in barley var. Ratna

increased significantly with increasing levels of nitrogen upto 80 kg/ha. Application of nitrogen and its combined use with biofertilizers improved the yield, quality and uptake of nutrients by the crop. Inoculation of crop with either of the bacteria receiving moderate level of N gave similar yields as the uninoculated crop receiving higher dose of N.

Turk and Shatanawi (2001) reported from Irbid, Jordan that nitrogen application based on calendar date is not the most effective use of nitrogen, because the developmental stage of the crop at that time is ignored. The objective of this study was to investigate the importance of timing the recommended rate of nitrogen fertiliser according to certain developmental stages of the apex. A two-year field study using widely grown cultivars, ACSAD 176 and Rum *(Hordeum vulgare* L.) during the 1994-95 and 1995-96 growing seasons at a field site of the Jordan University of Science and Technology campus (JUST) in northern Jordan. Applications were timed to coincide with floral initiation, onset of stem elongation and booting stages. In general, nitrogen application split, two or three times, resulted in a significant increase of grain yield for both cultivars in both the seasons as compared with the traditional method of application. This increase in grain yield was associated with significant increase in spike number, 1000 grain weight, total biological yield and more interestingly, the harvest index (HI), especially for three-timed -application. However, late

single application at booting stage tended to reduce grain yield of both the cultivars due to decreased spike number and total biomass. For the cultivars studied, ACSAD 176 outyielded Rum in both the seasons due to higher 1000-grain weight, total biomass and the harvest index. In conclusion, this study suggests that nitrogen should be applied at certain critical developmental stages when the crop demand for nitrogen is high.

Paramjit *et al.* (2001) conducted a field experiment at Agronomy Research Area, CCS Haryana Agricultural University, Hisar. The experiement comprised four levels of irrigation and 4 levels of nitrogen (0, 30, 60 and 90 kg N ha^{-1}). The increasing levels of nitrogen upto 90 kg N ha^{-1} significantly increased growth, yield and yield-attributes of malt barley var. Alfa-93. Similar results have also been reported by many workers. (Awasthi and Bhan, 1994; Fathi *et al.*,1997; Subhash Chandra *et al.*, 1998; Dhukea *et al.*, 1998; and Saini and Thakur, 1999).

Baishander (2002) couducted experiment at Rewa (M.P.) and found that maximum grain of malt barley genotypes at 80 kg N/ ha, being significantly superior to 40 to and 60 kg N/ha. Among the genotypes, RD 2606 performed the best giving 40.87 q/ha grain yield and Rs. 20,630/ha net return. This was closely followed by RD 2503.

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METHODS & MATERIALS

MATERIALS AND METHODS

The present experiment was conducted at the research Farm of Brahmannad P.G. College, Rath (Hamirpur) U.P. The farm is situated near Rath town on roadside of Rath-Mahoba bus route in Southern region of Bundelkhand (U.P.). The field has good irrigation and drainage facilities with moderate slope towards the direction from West to East.

The field experiment was started from *rabi* (winter) of I year and continued to the next winter season of II year. The materials used and the methodology adopted to carry out this research and the periodical observations recorded in the field and in laboratory including chemical analysis work are being presented in this chapter.

3.1 Experimental field soil :

The textural classification of the field soil was clay-loam. Before starting the experiment in *rabi* 1st year and 2nd year the soil samples were collected randomly through a soil-auger from the different spots of the experimental plot up to 15 cm depth to form composite samples. These soil samples were subjected to determine the physico-chemical properties of the soil by following the standard chemical procedures (Table-1)

It is not needed to write full procedure of determinations of different attributes a reference may be quoted it will serve the purpose

The soil was neutral in reaction, high in available potassium, medium in organic matter, available nitrogen and phosphorus. The topography of the field was fairly uniform having mild slope to facilitate efficient drainage.

3.2 Determination of chemical properties of soil pH :

3.2.1 Determination of soil pH (Blackman's pH meter)

Taken 10g of the soil and added 25ml distilled water. Shaken and after 30 minutes, dipped both the glass electrodes and the calomel electrode in the soil suspension. Connected the electrode to the pH meter. Switched on the current and increased or decreased resistance in the external circuit so that potential of the electric power equalizes the potential of the cell containing soil suspension and the galvanometer needle stands at zero. The pH of the soil was noted from the scale.

3.2.2 Electrical conductivity (EC) :

Preparation of standard potassium chloride (KCl) solution :

Dissolved 0.7456g of dry reagent grade KCl in double distilled water and made to one litre. At 25°C gives an EC of 1411.8×10^{-6} (0.0014118) mm hos/cm or 1.41 mm hos/cm. The conductivity bridge is to be calibrated and cell constant determined

with the help of KCl solution.

Shaken 20 g of soil with 40 ml of distilled water in a 150 ml conical flask for one hour and allowed to stand. The conductivity of the supernatant liquid was determined with the help of the salt (conductivity) bridge. The measurement of EC (expressed in mm hos/cm was adjusted at 25^0C of the solution by setting there knob provided for this purpose.

Table-1 Physico-chemical properties of the experimental soil

S. No.	Soil constituents	Values obtained		Method of determination
		I year	IInd year	
1.	Mechanical composition			
	a) Coarse Sand (%)	28.36	28.43	International Pipette method
	b) Silt (%)	50.42	47.93	(Piper, 1950) -do-
	c) Clay (%)	21.22	23.64	-do-
	d) Texture	Silty loam Parua	Silty loam Parua	
2.	Chemical component Soil pH (1:2 soil-water ratio)	7.8	7.6	Blackman glass electrode pH meter (Black, 1965).
3.	Electrical conductivity d S/m	0.23	0.40	Electrical conductivity meter (Black, 1965)
4.	Organic carbon (%)	0.49	0.53	Walkley and Black's method (Black, 1965) mm hos./cm

5.	Available nitrogen (Kg/ha)	165	183	Alkaline-Paramagnet method (Subbiah and Asija, 1956)
6.	Available phosphorus (Kg/ha)	26.84	26.80	Olsen's method (Olsen et al., 1954)
7.	Available potassium (Kg/ha)	208.5	207.8	Flame photometer (Muhur et al., 1965)
8.	Calcium carbonate (%)	4.80	4.78	Ammonium acetate method (Piper, 1950)

3.2.3 Organic carbon (%) :

no need to write whole procedure

Taken 10g of soil (0.5 mm sieved) in a 500 ml conical flask. Added 10 ml of 1 N potassium dichromate solution and 20 ml of concentrated sulfuric acid. Shaken well for a minute or two and allowed it to stand on an asbestos mat, for 30 minutes. Added 200 ml of water, 10 ml of phosphoric acid and 1 ml. of diphenylamine indicator solution, A deep violet colour was appeared. Titrated it with N/2 ferrous ammonium sulphate solution till the violet colour changed to purple and finally to green. Added 0.5 ml of potassium dichromate solution accurately with a burette or pipette and titrated with ferrous sulphate solution until the colour changed to green. In the same ways carried out a blank determination also and calculated the results as follows :

Weight of soil taken = wg

Volume of 0.5 N ferrous ammonium sulphate required for reducing 10.0 ml

$K_2Cr_2O_7$ Solution = x ml (blank reading).

Volume of 0.5 N ferrous ammonium sulphate required for reducing the excess of dichromate = y ml (experimental reading)

Difference = x-y ml

1 ml of 1 N $K_2Cr_2O_7$ - 0.003 g of carbon

Percentage of carbon in the soil = $\frac{(x-y)x0.003x100}{2xwg} = z$

Percentage of organic matter = $\frac{zx100}{58}$

or z x 1.724 in the soil

Note : Assuming that organic matter contains 58% carbon the per cent of organic matter can be calculated by multiplying the Walklay Black value with 100/58 or 1.724.

3.2.4 Available nitrogen in soil :

Taken 20 g of the soil sample in distillation flask and added 20 ml of water. Added 100 ml of 0.32% $KMnO_4$ solution and 100 ml of 2.5% sodium hydroxide solution and immediately fitted it up in the distillation apparatus. Pipetted 20 ml of 0.2 N sulfuric acid in a conical flask and dipped the end of the delivery tube in it. Distilled ammonia gas from the distillation flask and collected about 30 ml of the filtrate. Then added 5 drops of methyl red indicator and titrate with 0.05 N sodium hydroxide. The calculation was done in the following way.

not needed

Weight of soil taken = 20 g

Volume of 0.02 N H_2SO_4 taken = 20 ml

Volume of 0.02 N NaOH used = x ml

Available nitrogen = (20 - x) x 20 kg/ha

3.2.5 Available phosphorus in soil :

Taken 10 g of the soil and added 20 ml of N/2 $NaHCO_3$ and a pinch of Darco G. 50 Shaken the mixture for 10 minutes and filtered and washed with water. Added 10 ml of ammonium molybdate solution and 5 ml $SnCl_2$ solution. Shaken well and made volume to 50 ml, compared the blue colour calorimetrically and calculated P_2O_2 in the soil.

3.2.6 Available potash in soil :

Taken 5 g of the soil in a test tube and added 10 ml of Morgan's reagent in it. Shaken it for 5 minutes and filtered. Now taken 2 ml of the filtrate and diluted to 10 ml. Selected a suitable Nessler cylinder and mixed in it 2 ml alcohol mixture, 6 drops of sodium cobaltiritrite solution and 3 ml of diluted extract (1:5) and shaken. Compared the turbidity produced with standard potassium chloride solution and treated in the same manner. The temperature was maintained below 20°C by cooling throughout the experiments. Calculation was done as follows : Taken 1, 2, 3, 5, 6 ml of standard solution of KCl in different tubes and treated exactly in the same manner as in soil extract. Suppose, the turbidity

produced in the unknown sample matches with the standard containing 3.0 ml of standard.

Volume of standard KCl taken = 3.0 ml.

Amount of K present = 3 mg

This weight is present in 2 ml of the unknown solution.

Weight of K present in 10 ml = 3 mg.

Weight of soil = 5g

Hence, amount of K in 100g soil= $\frac{100}{5} x3$ = 60 mg

= 0.0600g

3.3 Geographical Situation :

Geographically, Rath, Hamirpur district lies in the sub-tropical zone at a latitude and longitudinal range of 79.7^0 East and 25.5^0 North. It is located ~~to~~ at an elevation ~~range~~ of 526 feet from the sea level. The annual rainfall ranges between 800-900 mm which is received mostly from last week of June to last September with occasional showers in winter.

3.4 Climate and season :

Bundelkhand has sub-tropical with hot days during summer and cold in winter. The mean weekly temperature (maximum and minimum), relative humidity and total rainfall were recorded ~~from~~ at the meteorological observatory of Indian Grassland and Fodder Research Institute (I.G.F.R.I.), Jhansi, U.P. are given in Table 2 and 3.

Table-2 Meteorological data during *Rabi* season of I year

Standard week number	Period of Standard weekly	Temperature		Relative Humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
45	6 Nov. to 12 Nov.	29.0	13.8	97	44	-
47	13 Nov. to 19 Nov.	28.0	12.9	97	44	-
47	20 Nov. to 26 Nov.	24.0	14.0	96	67	-
48	27 Nov. to 03 Dec.	21.7	13.3	96	68	-
49	4 Dec. to 10 Dec.	21.6	13.0	97	76	-
50	11 Dec. to 17 Dec.	19.3	8.6	96	76	-
51	18 Dec. to 24 Dec.	16.7	7.8	96	74	-
52	25 Dec. to 31 Dec.	16.0	6.7	96	75	-
01	1 Jan. to 7 Jan.	18.1	5.4	97	48	-
02	8 Jan. to 14 Jan.	19.1	5.8	97	52	-
03	15 Jan. to 21 Jan.	20.7	5.5	96	44	-
04	22 Jan. to 28 Jan.	20.7	5.8	96	38	-
05	29 Jan. to 4 Feb.	23.5	9.8	96	50	-
06	5 Feb. to 11 Feb.	24.0	6.4	90	33	-
07	12 Feb. to 18 Feb.	29.9	11.2	87	27	-
08	19 Feb. to 25 Feb.	25.0	10.1	89	37	3.2
09	26 Feb. to 03 Mar.	25.6	8.8	94	33	5.2
10	4 Mar. to 10 Mar.	27.7	11.8	91	32	2.1
11	11 Mar. to 17 Mar.	28.3	12.2	93	38	-
12	18 Mar. to 24 Mar.	31.8	14.8	92	30	-
13	25 Mar. to 31 Mar.	32.3	13.5	90	29	-

Meteorological data during *Rabi* season of I year

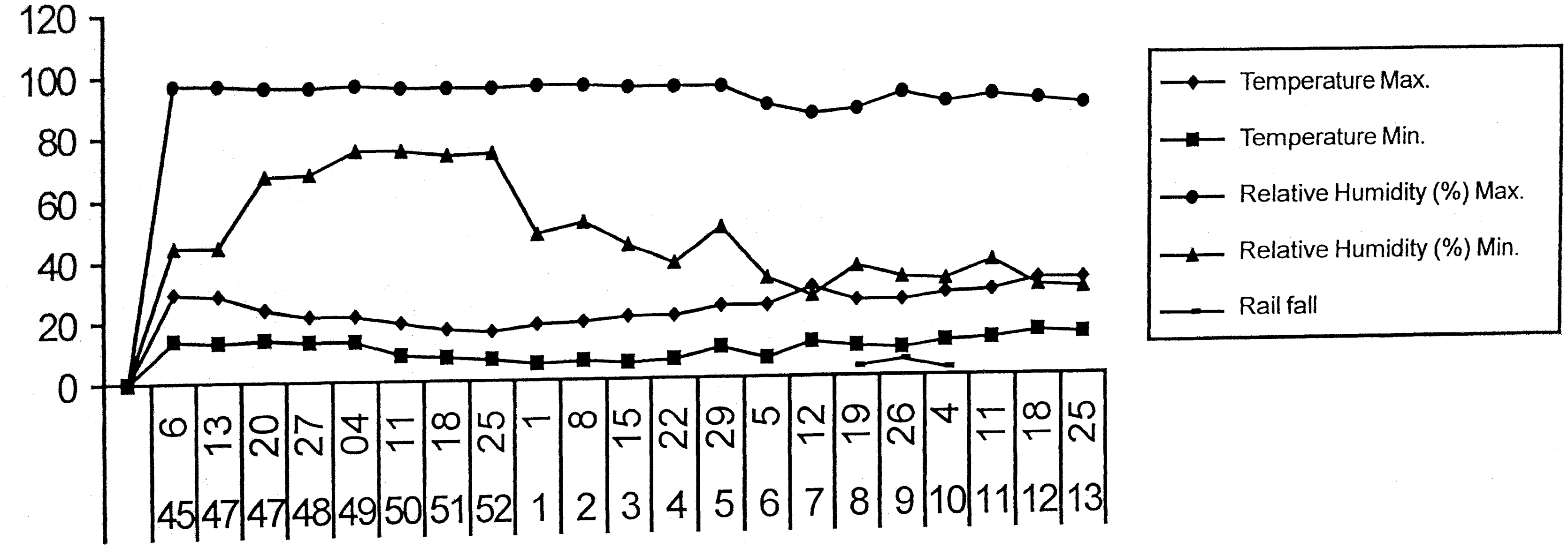
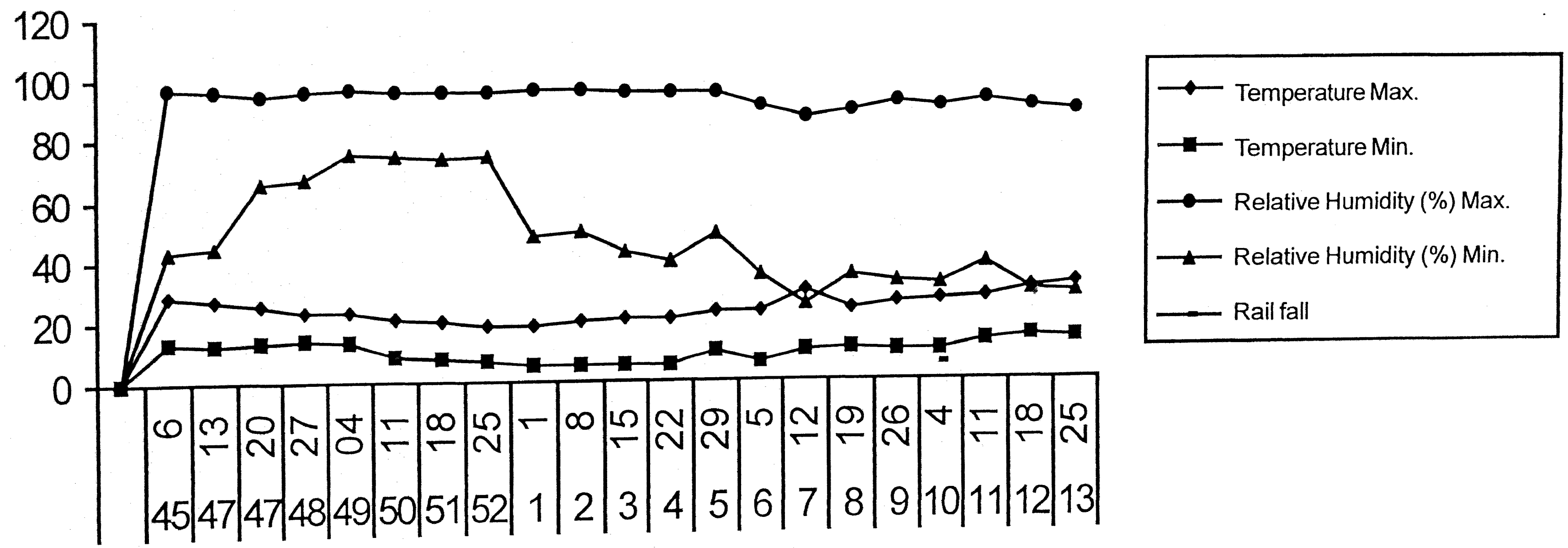


Table- 3 Meteorological data during *Rabi* season of IInd year

Standard week number	Period of Standard week~~ly~~	Temperature		Relative Humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
45	6 Nov. to 12 Nov.	28.0	12.7	97	43	-
47	13 Nov. to 19 Nov.	27.0	11.9	96	44	-
47	20 Nov. to 26 Nov.	25.0	13.0	95	66	-
48	27 Nov. to 03 Dec.	22.7	13.8	96	67	-
49	4 Dec. to 10 Dec.	22.6	13.0	97	76	-
50	11 Dec. to 17 Dec.	20.3	8.2	96	75	-
51	18 Dec. to 24 Dec.	19.5	7.5	96	74	-
52	25 Dec. to 31 Dec.	18.0	6.7	96	75	-
01	1 Jan. to 7 Jan.	18.3	5.2	97	48	-
02	8 Jan. to 14 Jan.	19.5	5.5	97	50	-
03	15 Jan. to 21 Jan.	20.7	5.7	96	43	-
04	22 Jan. to 28 Jan.	20.9	5.7	96	40	-
05	29 Jan. to 4 Feb.	22.6	9.6	96	49	-
06	5 Feb. to 11 Feb.	23.0	6.0	92	35	-
07	12 Feb. to 18 Feb.	30.0	10.2	88	25	-
08	19 Feb. to 25 Feb.	24.0	10.5	90	35	-
09	26 Feb. to 03 Mar.	25.8	9.8	93	33	-
10	4 Mar. to 10 Mar.	26.7	10.2	92	32	5.7
11	11 Mar. to 17 Mar.	27.4	13.2	94	39	-
12	18 Mar. to 24 Mar.	30.8	14.8	92	30	-
13	25 Mar. to 31 Mar.	31.9	13.5	90	29	-

Meteorological data during *Rabi* season of II year



3.5 Cropping history :

The cropping history of the field during last 5 years have been given in Table-4.

Table-4 Details of cropping sequences

S.No.	Year	Kharif	Rabi	Zaid
1.	1997-1998	Fallow	Wheat	
2.	1998-1999	Moong	Mustard	
3.	1999-2000	Soyabean	Wheat	
4.	2000-2001	Moong	Present Experiment (Barley)	
5.	2001-2002	Fallow	Present Experiment (Barley)	

3.6 Experiments details :

double

The present experiments was laid out in split plot design. In all, there were 32 treatment combinations as indicated in Table 5 alongwith the abbreviated symbols used in the experimental plan for barley.

All the 32 treatments were randomly arranged in three replications.

Table-5 Details of the treatments

1.	Main-plot treatments	Varieties (4)
		(i) V_1 - (RD-2503)
		(ii) V_2 - (RD-2552)
		(iii) V_3 - (K-560)
		(iv) V_4 - (DL-88)
2.	Sub-plot treatments	Date of Sowing x Nitrogen levels (8)
		Date of Sowing (2)
		(i) D_1 - (7 November)
		(ii) D_2 - (27 November)
3	Sub. Sub plot treatments	Nitrogen levels (4)
		(i) N_1 - (Control)
		(ii) N_2 - (30 kg/ha)
		(iii) N_3 - (60 kg/ha)
		(iv) N_4 - (90 kg/ha)

3.7 Design of the experiment :

The experiment was laid out in a Double split-plot design with varieties as main-plot treatment and date of Sowing & Nitrogen levels as sub-plot, sub-sub plot treatment respectively. The particulars of the layout are given in Table-6 and shown in Fig. 2.

Table-6 Particulars of the layout details

Particulars	Details
Replications	3
Main plots within replication	4
Sub plots within main plot	~~8~~ 2
Sub-Sub plots within subplot	- 4
Plots in the replication	32
Total plots in experiment	96
Rows/plot	10 (23 cm apart)
Plot size	
i) Gross	5.0m x 2.30m (10 rows)
ii) Net	4.50m x 1.84m (8 rows)
Replication alley	1.0m
Main plot alley	1.0m
Sub plot alley	50cm
Sub-Sub plot alley	50 cm
Experimental area	11.5 x 96 = 1104m^2

3.8 Varietal characters :

Four varieties of barley were taken as experimental material for the study. They were selected on the basis of high yield performance at the various locations in the country. Details of characteristics of the varieties are given in Table 7.

Layout plan of experimental field

R_1		R_2		R_2 3	
$V_2D_2N_2$	$V_2D_1N_1$	$V_2D_2N_3$	$V_2D_1N_1$	$V_2D_1N_2$	$V_2D_2N_3$
$V_2D_2N_0$	$V_2D_1N_3$	$V_2D_2N_2$	$V_2D_1N_3$	$V_2D_1N_0$	$V_2D_2N_1$
$V_2D_2N_1$	$V_2D_1N_0$	$V_2D_2N_0$	$V_2D_1N_2$	$V_2D_1N_3$	$V_2D_2N_0$
$V_2D_2N_3$	$V_2D_1N_2$	$V_2D_2N_1$	$V_2D_1N_0$	$V_2D_1N_1$	$V_2D_2N_2$
$V_1D_1N_0$	$V_1D_2N_2$	$V_1D_1N_0$	$V_1D_2N_3$	$V_1D_2N_0$	$V_1D_1N_1$
$V_1D_1N_1$	$V_1D_2N_3$	$V_1D_1N_3$	$V_1D_2N_0$	$V_1D_2N_2$	$V_1D_1N_2$
$V_1D_1N_2$	$V_1D_2N_0$	$V_1D_1N_1$	$V_1D_2N_2$	$V_1D_2N_2$	$V_1D_1N_0$
$V_1D_1N_3$	$V_1D_2N_1$	$V_1D_1N_2$	$V_1D_2N_1$	$V_1D_2N_3$	$V_1D_1N_2$
$V_3D_1N_3$	$V_3D_2N_2$	$V_3D_2N_2$	$V_3D_1N_3$	$V_3D_1N_2$	$V_3D_2N_3$
$V_3D_1N_1$	$V_3D_2N_0$	$V_3D_2N_1$	$V_3D_1N_0$	$V_3D_1N_1$	$V_3D_2N_2$
$V_3D_1N_2$	$V_3D_2N_1$	$V_3D_2N_0$	$V_3D_1N_2$	$V_3D_1N_3$	$V_3D_2N_0$
$V_3D_1N_0$	$V_3D_2N_3$	$V_3D_2N_3$	$V_3D_1N_1$	$V_3D_1N_0$	$V_3D_2N_1$
$V_4D_2N_3$	$V_4D_1N_0$	$V_4D_1N_2$	$V_4D_2N_0$	$V_4D_2N_3$	$V_4D_1N_2$
$V_4D_2N_0$	$V_4D_1N_1$	$V_4D_1N_0$	$V_4D_2N_2$	$V_4D_2N_1$	$V_4D_1N_3$
$V_4D_2N_2$	$V_4D_1N_3$	$V_4D_1N_3$	$V_4D_2N_1$	$V_4D_2N_2$	$V_4D_1N_0$
$V_4D_2N_1$	$V_4D_1N_2$	$V_4D_1N_1$	$V_4D_2N_3$	$V_4D_2N_0$	$V_4D_1N_1$

Irrigation Channel

Irrigation Channel

Irrigation Channel

1.84 m

4.5 m

5 m

2.3 m

1 m

47.8 m

35.5 m

Mend = 0.5 m., Field border = 1.5 m., Irrigation channel = 1.0 m., Plot area of single plot = 11.5 m., Total plot area = 1697 sq.mt.

Table-7 General characteristics of the varieties :

Variety	Origin	Heading (days)	Maturity (days)	Tillers/m row length	Height (cm)	Test weight (gm)	Yield (q/ha)
RD 2503	Durgapur (Rajasthan)	75	115	49	63	40.8	38.4
RD 2552	Durgapur (Rajasthan)	81	123	86	68	42.5	41.5
K- 560	Kanpur	-	114	63	80.3	43.0	33.8
DL-88	Ludhiana (Punjab)	71	116	50	76	39.5	40.6

3.9 Details of field operation :

3.9.1 Preparation of the field :

The field was ploughed by tractor drawn cultivator twice, followed by one planking.

3.9.2 Fertilizer application :

The application of 40 kg P_2O_5 and 20 K_2 0/ha and half of the nitrogen according to N levels (No, N_1, N_2, & N_3) levels per hectare by using single super phasphate urea and muriate of Potash was done. The fertilizers were weighed for each plot as per schedule and thoroughly mixed in the soil before sowing the seed. The second half of the nitrogen was given after 45 days of sowing.

3.9.3 Seed rate :

One hundred kilograms of seed per hectare was used. The seeds were treated with Thirum @ 3 g/kg of seed before sowing.

3.9.4 Methods of sowing :

Seeds were sown in rows, 23cm apart and thereafter covered by loose soil immediately after seeding.

3.9.5 Irrigation :

In all two irrigations were given at 30 and 60 days stage of the plant growth.

3.9.6 Crop management :

The infestation of seasonal weeds was started after a month of sowing. Therefore, one hand-weeding was performed after 35 days of sowing by manual labours to avoid the competition of weeds within the crop stands.

3.9.7 Harvesting :

To eliminate the border effect one row of each side and 50cm from either ends were cut out and only net plot was harvested and threshed separately for grain yield.

Table 8 Details of operations datewise : (1st and 2nd year)

S.N.	Field operations		Date of operation	Days after swoing	Remarks
1.	Deep ploughing		3.11 1st and 2nd year		By tractor
2.	Disking & Harrowing		4.11 1st and 2nd year		By tractor
3.	Lay out		5.11 1st and 2nd year		By labourers
4.	Fertilizer application		a) 6.11 1st and 2nd year		Application of half
	A		b) 26.11 1st and 2nd year		dose of N, full dose P
5.	Sowing of seed		a) 7.11 1st and 2nd year		& K
			b) 27.11 1st and 2nd year		-
6.	Irrigation (I&II)	I	a) 7.12 1st and 2nd year	30	-
			b) 27.12 1st and 2nd year	30	-
		II	a) 7.1 1st and 2nd year	60	-
			b) 27.1 1st and 2nd year	60	-
7.	Weeding		a) 13.12 1st and 2nd year	60	Hand weeding
			b) 3.1 1st and 2nd year	35	Hand weeding
8.	Fertilizer application		a) 22.12 1st and 2nd year	45	Balance dose of N
	B		b) 11.01 1st and 2nd year	45	Balance dose of N
9.	Harvesting		a) 6.3 1st and 2nd year	118	Labourers
			b) 30.03 1st and 2nd year	122	Labourers
10.	Threshing and cleaning		a) 7.8 1st and 2nd year	-	Labourers
			b) 01.02 1st and 2nd year	-	Labourers

It has been mentioned that at one hand weeding has given

3.9.8 Sampling technique :

Five plants were selected at random in each plot. The plants were tagged and all observations pertaining to pre and post harvest

studies were recorded from the same. The following characters were studied to determine the response of different treatments.

have been

3.10 Observations to be recorded :

(a) Growth attributes :

1. Plant population per running metre at 30, 60 and 90 days after sowing and at harvest.
2. No. of tillers/plant at 30, 60 days after sowing.
3. Plant height at 30, 60 and 90 days after sowing and at harvest.
4. Number of functional leaves/plant at 30, 60 and 90 days after sowing.
5. Leaf area index at 30, 60 and 90 days after sowing.
6. Fresh and dry weight/plant at 30, 60 and 90 days after sowing and at harvest.

(b) Yield and yield attributes

1. No. of spikes per plant {How it was recorded}
2. Spike length (cm)
3. No. of spikelets/spike
4. No. of grains/spike
5. Grain weight/spike
6. Total produce, grain yield, straw yield/kg plot and quintal per hectare
7. Harvest index

8. Test weight

(c) Soil studies

1. Initial soil fertility of the experimental site.

(d) Qualitative studies

1. Protein content of seed.

(e) Economics

Cost of cultivation, gross income, net income and cost : benefit ratio.

(a) Growth Attributes :

1. Plant population

Number of plants per metre row lenght was recorded in three places/plot by counting the plants at 30 days after sowing and before maturity stage.

2. Number of tillers per metre row length

Total number of tillers/m row lenght were counted from the net plot and average was worked out. ~~These~~ This observation~~s~~ ~~were~~ was recorded at 60 days stage of plant growth.

3. Number of tillers per plant

Number of tillers per plant was counted from the three randomly selected plants and then averages were calculated in each treatments.

4. Height of the plant

Main shoot was taken to represent the height of plant.

Shoot length was taken from the ground level to the tip of the last fully opened leaf. Each sample plant~~s~~ was measured at an interval of 30 days.

5. **Number of functional leaves per plant**

The number of functional leaves per plant was counted and the averages was ~~were~~ computed in each case.

6. **Leaf area index**

It expressess total leaf area in relation with the total ground area in which the crop is grown

A = Total leaf area of the crop

P = Total ground area under crop

LAI = A/P

7. **Fresh weight (g) per plant**

Five plants from next to border (second line from outer side) were cut from ground level and weighted finally fresh weight per plant was computed.

8. **Dry weight (g) per plant**

The above sample was kept in oven for 48 hrs at 65°C and weighted till the costant weight is obtained jointly for the calculation of average dry weight per plant, and then dry matter accumulation was calculated.

(b) Yield and yield attributes :

1. **No. of spikes per plant**

The number of ears plant was counted and average~~s~~

~~were~~ was calculated in each treatment.

2. Spike length (cm)

The length of earhead was measured from the ring to the tip of the spike to represent the length of earhead. In all five ears were taken for this observation~~s~~ from each treatment. The average~~s~~ ~~were~~ was worked out.

3. No. of spikelets per spike

The number of spikelets ~~were~~ was counted from the five ears of selected plant and then average was calculated in each treatment.

4. Number of grains per spike

The number of grains ~~were~~ was counted from the five earheads and the average was worked out for each treatment for making statistical analysis ~~work~~.

5. Weight of grains per spike

The weight of grains from five earheads was recorded ~~in~~ by an electrical balance and the average value was worked out in each treatment.

6. Seed and straw yield/plant

The seed and straw yield of the same five sample-plants was recorded from each plot and the value averaged as seed and straw yield per plant.

a) Grain yield per hectare

After sun drying, threshing and winnowing, grain

yield of each plot (harvested net plot - plot sample plants) was recorded separately in kilograms and then converted into quintals per hectare.

b) **Straw yield per hectare**

Straw yield per plot was recorded in kilograms and then converted into quintals per hectares.

7. **Harvest index (%)**

It is ratio of economic yield (grain) to the biomass (biological yield) at harvest and expressed as percentage. The harvest index was calculated by following formula.

$$HI\ \% = \frac{\text{Economic yield (grain)}}{\text{Biological yield (grain + straw)}} \times 100$$

8. **Test weight (1000 grain weight)**

Two samples of 1000 grain were drawn from finally cleaned produce of each plot and weighted with the help of electrical balance and mean value was taken.

9. **Economics of the treatment**

The cost of cultivation and income per hectare for various treatments were calculated at prevailing market rates.

10. **Quantitative studies :**

Protein content (%)

Total nitrogen content of seed will be determined by Mico-kjeldhal method (Jackson, 1967). Nitrogen content of grain

will be multiplied by 6.25 to get total crude protein content (percent).

3.11 Statistical analysis :

The data recorded for various growth and yield attributing characters of grain and straw yield were statistically analysis (Fisher, 1957).

$$\frac{a \times y - b \times y/x}{E\ x^2 - (E\ x/x)^2}$$

The skeleton of analysis of variance is presented in Table-8.

Table-~~9~~ 8 The skeleton of analysis of variance

Source of ~~Variance~~ variation	d.f	S.S.	M.S.S.	F cal.	F table at 5%
Replications	2				
Varieties (v)	3				
Error (a)	6				
Date of sowing	1				
Variety x Dates	3				
Error (b)	8				
N-levels	3				
V x N-levels	9				
Dates x N-levels	3				
V x Dates x N-levels	9				
Error (c)	48				
Total	95				

This skeleton shows that experiment has been conducted in double split plot design but in text it has been mentioned that experiment has been laid out in split plot design. It is highly objectionable.

3.12 Test of Significance :

To test the significant difference among the treatment means, the following formulae were used for calculating the critical differences for main plots, sub-plots and interactions :

S.E.± for variety (V)	=	$\frac{\sqrt{2VE}}{3x2x4}$
C.D. at 5%	=	$\frac{\sqrt{2VE}}{3x2x4}$ x t at 5% (6 D.F.)
S.E.± for sowing date (D)	=	$\frac{\sqrt{2VE}}{3x4x4}$
C.D. at 5%	=	$\frac{\sqrt{2VE}}{3x4x4}$ x t at 5% (8 D.F.)
S.E. ± for Nitrogen (N)	=	$\frac{\sqrt{2VE}}{3x2x4}$
C.D. at 5%	=	$\frac{\sqrt{2VE}}{3x2x4}$ x t at 5% (48 D.F.)
S.E. ± for (V x S)	=	$\frac{\sqrt{2VE}}{3x4}$
S.E. ± for (V x N)	=	$\frac{\sqrt{2VE}}{3x2}$
S.E. ± for (D x N)	=	$\frac{\sqrt{2VE}}{3x4}$
S.E. ± for (V x D x N)	=	$\frac{\sqrt{2VE}}{3}$

****

All the formulae have been wrongly presented.

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS

S

The experimental observation data were recorded periodically on vegetative growth characters, yield attributing parameters, grain and straw yields and grain protein percentage under various treatments and their combinations. After that, these data were subjected to statistical computation and then presented the results in this chapter.

4.1 Growth attributes :

4.1.1 Plant population :

The data on plant population m/row length are presented in Table 4.1 and 4.2. Varieties (V) sowing dates (D) and N levels as well as VxD interactions deviated the plant population significantly in both the years. K-560 by recorded significantly higher plant population (24.96 and 28.92 plants/running metre) over rest of the varieties, however, the lowest being in case of RD 2503 (21.71 and 25.87 plants/running metre) in both the years. Increasing N levels encouraged this parameter, thus maximum N level (N_{90}) recorded significantly higher 24.04 and 28.30 plants/ running metre as against the lowest values (22.0 and 26.62 plants) in case of No level in the respective years. Late sowing (20 November)) discouraged this parameter significantly over the normal sowing of

Table 4.1 Plant population per running mt. metre at 30 days as influenced by various treatments and their interaction (I year)

Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	22.00	23.00	26.00	22.00	**23.25**
	N_{30}	22.33	23.67	26.33	23.33	**23.91**
	N_{60}	23.00	25.00	27.00	24.00	**24.75**
	N_{90}	23.67	26.00	27.67	24.33	**25.42**
	MEAN	**22.75**	**24.72**	**26.75**	**23.41**	**24.33**
27-Nov	N_0	20.00	21.00	22.00	20.00	**20.75**
	N_{30}	20.33	22.00	23.00	21.00	**21.58**
	N_{60}	21.00	22.33	23.67	21.33	**22.08**
	N_{90}	21.33	23.00	24.00	22.33	**22.66**
	MEAN	**20.66**	**22.08**	**23.17**	**21.16**	**21.77**
OVER ALL MEAN		**21.71**	**23.25**	**24.96**	**22.39**	

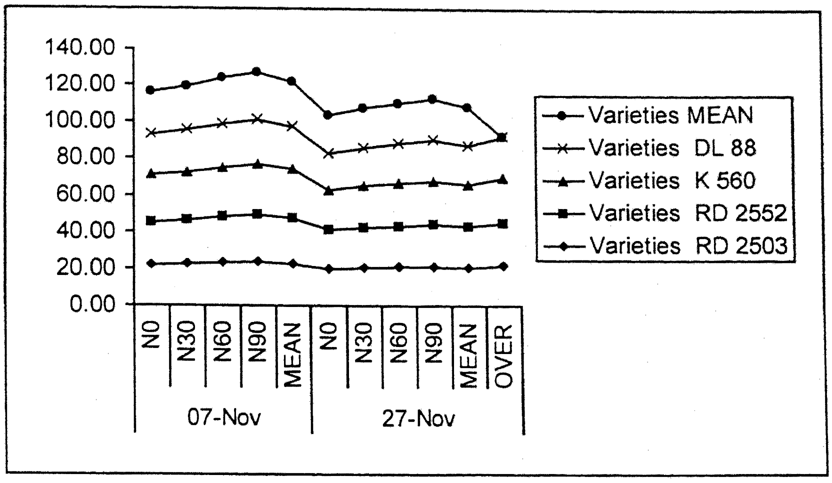
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	21.00	21.33	22.00	22.50	**21.71**
RD2552	22.00	22.83	23.66	24.50	**23.25**
K-560	24.00	24.66	25.33	25.83	**24.96**
DL-88	21.00	22.16	22.66	23.33	**22.39**

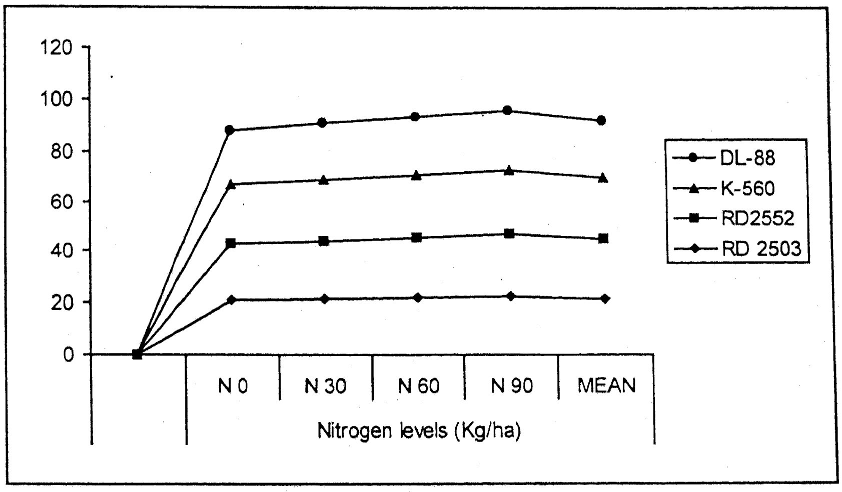
Nitrogen levels (Kg/ha)

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	23.25	23.91	24.75	25.42	**24.33**
27 NOV.	20.75	21.58	22.08	22.66	**21.77**
MEAN	**22.00**	**22.74**	**23.41**	**24.04**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt.±	0.38	0.29	0.58	0.42	0.85	0.60	0.59
C.D. 5%	0.94	0.66	N.S.	0.85	N.S.	N.S.	N.S.

Graph-4.1 **Plant population per running ~~mt.~~ metre at 30 days as influenced by various treatments and their interaction (I year)**





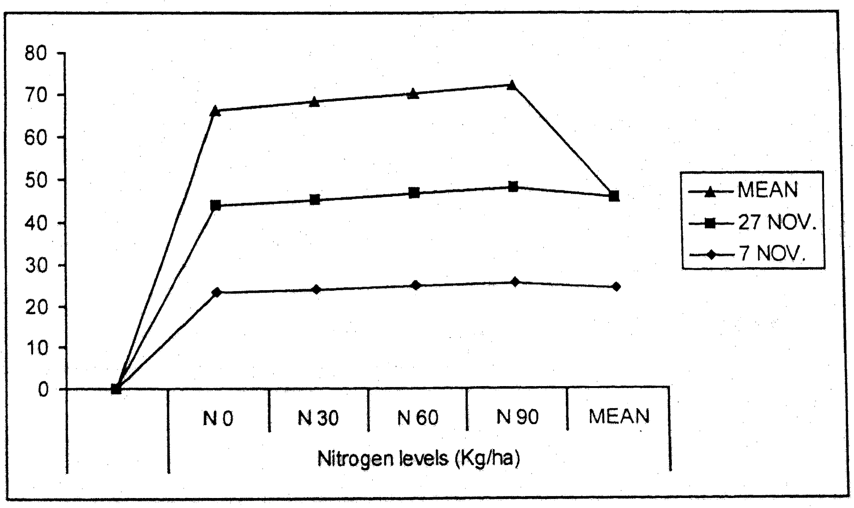


Table 4.2 **Plant population/running meter at 30 days as influenced by various treatments and their interaction (II year)**

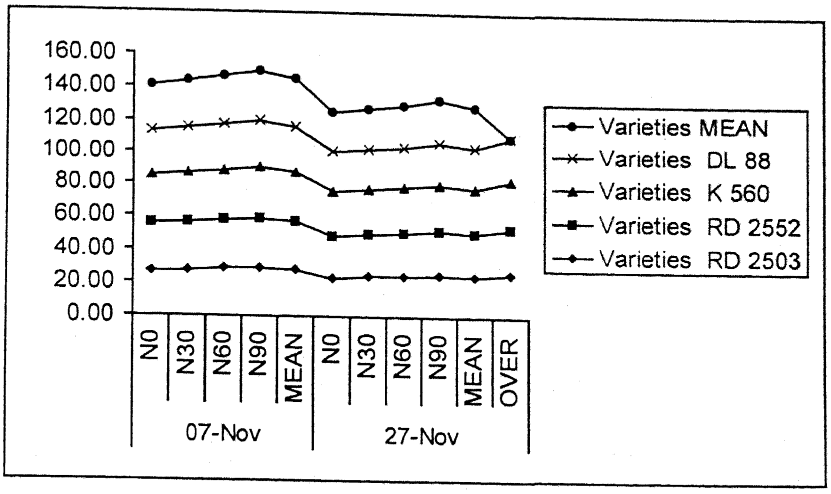
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	26.67	29.00	29.67	27.33	**28.17**
	N_{30}	27.33	29.33	30.00	28.67	**28.83**
	N_{60}	28.33	29.67	30.33	29.33	**29.41**
	N_{90}	28.67	30.33	31.00	29.67	**29.92**
	MEAN	**27.75**	**29.58**	**30.25**	**28.75**	**29.08**
27-Nov	N_0	23.00	25.67	27.00	24.67	**25.08**
	N_{30}	24.00	26.00	27.33	25.00	**25.58**
	N_{60}	24.33	26.33	27.67	25.33	**25.92**
	N_{90}	24.67	27.33	28.33	26.33	**26.67**
	MEAN	**24.00**	**26.33**	**27.58**	**25.33**	**25.81**
	Over all mean	**25.87**	**27.97**	**28.92**	**27.04**	

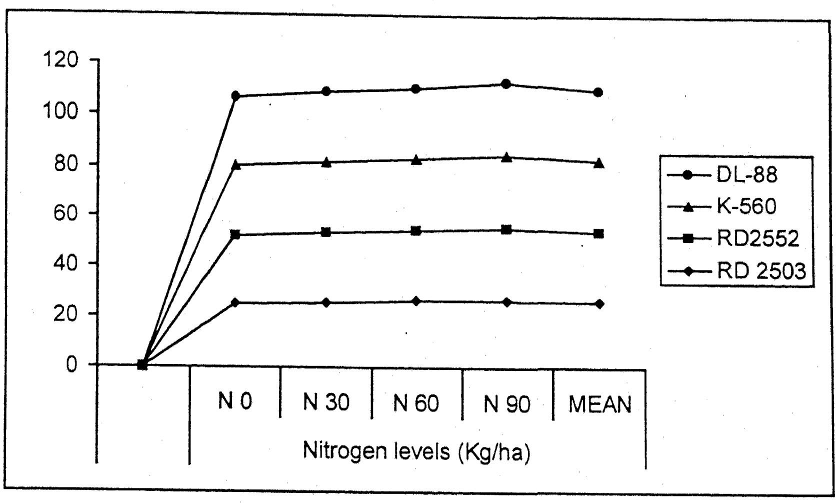
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	24.83	25.67	26.33	26.67	**25.87**
RD2552	27.34	27.67	28.00	28.83	**27.97**
K-560	28.33	28.67	29.00	29.67	**28.92**
DL-88	26.00	26.84	27.33	28.00	**27.04**

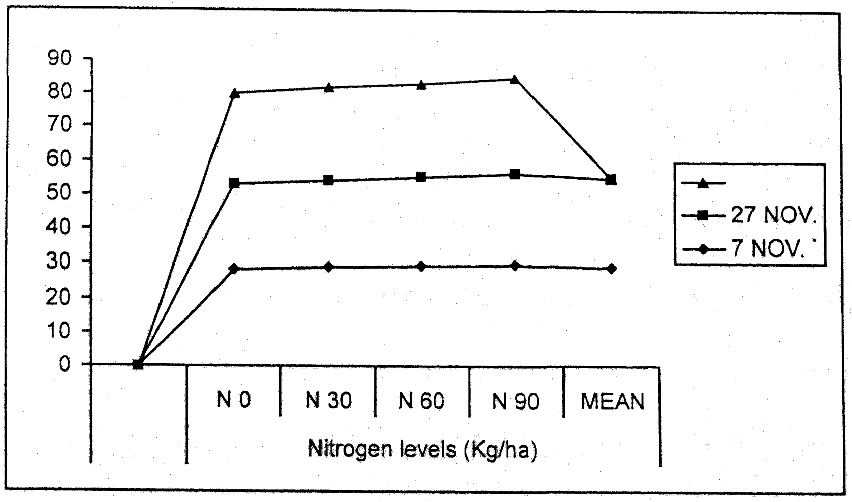
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	28.17	28.83	29.41	29.92	**29.08**
27 NOV.	25.08	25.58	25.92	26.67	**25.81**
MEAN	**26.62**	**27.20**	**27.67**	**28.30**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.EM±	0.09	0.07	0.14	0.23	0.46	0.32	0.29
C.D. 5%	0.22	0.16	0.32	0.46	N.S.	N.S.	N.S.

Graph-4.2 **Plant population/running meter at 30 days as influenced by various treatments and their interaction (II year)**







7 November. The plant population declined from 24.33 to 21.77 plants in first year, and 29.08 to 25.81 plants in second year.

4.1.2 Plant height at 30 DAS :

Plant height was found to be influenced significantly due to varieities, sowing dates and N levels but not due to treatment effect interactions in both the years (Table 4.3 and 4.4). Among the varieties, K 560 recorded significantly higher plant height (18.08 cm in first year and 23.44 cm in second year) over rest of the varieties. This was followed by DL 88. The lowest height (13.26 cm and 17.65 cm in respective years) was recorded in case of RD 2503. This parameter was significantly discouraged due to late sowing by 20 days (i.e. 27 November). Increasing N levels increased the height significantly in both the years. Accordingly, N_{90} resulted in maximum height (17.38 and 24.69 cm in the respective years) as against the lowest height (13.51 and 16.46 cm) from the No level (control).

4.1.3 Plant height at 60 DAS :

The plant height recorded after 60 days of sowing gave the similar trend as noted at 30 days stage (Table 4.5 and 4.6). The separate effect of each treatment persisted significant. However, the none of the treatment interactions exerted significant influence upon plant height. The variety K 560 continued to have recorded significantly higher plant height (45.23 cm and 55.08 cm in the

Table 4.3 **Plant height 30 days as influenced by various treatments and their interaction (I year).**

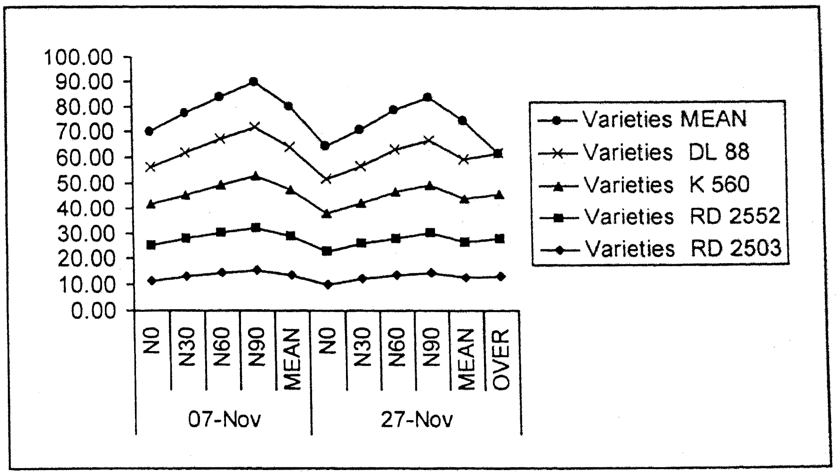
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	11.60	13.57	16.37	14.67	**14.05**
	N_{30}	13.47	14.47	17.50	16.60	**15.51**
	N_{60}	14.63	15.60	19.53	17.47	**16.81**
	N_{90}	15.40	16.57	21.47	18.43	**17.97**
	MEAN	**13.77**	**15.05**	**18.72**	**16.79**	**16.08**
27-Nov	N_0	10.30	12.50	15.47	13.60	**12.97**
	N_{30}	12.56	13.47	16.40	14.63	**14.26**
	N_{60}	13.67	14.53	18.40	16.53	**15.78**
	N_{90}	14.53	15.67	19.50	17.50	**16.80**
	MEAN	**12.76**	**14.04**	**17.44**	**15.56**	**14.95**
	OVER ALL MEAN	**13.26**	**14.54**	**18.08**	**16.17**	

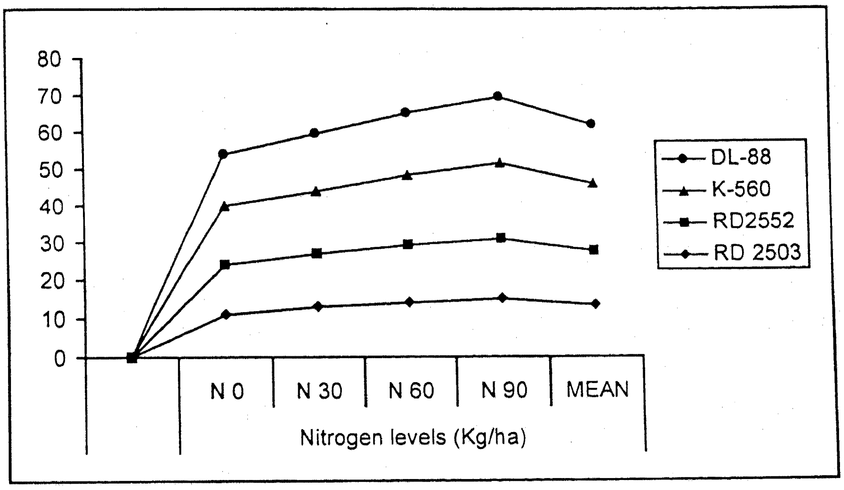
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	10.95	13.01	14.15	14.96	**13.26**
RD2552	13.03	13.97	15.06	16.12	**14.54**
K-560	15.92	16.95	18.96	20.48	**18.08**
DL-88	14.13	15.61	17.00	17.96	**16.17**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	14.05	15.51	16.81	17.97	**16.08**
27 NOV.	12.97	14.26	15.78	16.80	**14.95**
MEAN	**13.51**	**14.88**	**16.29**	**17.38**	

	V	D	V x D	N	V x N	D x N	V x D.x N
S.EM.±	0.64	0.28	0.57	0.54	1.07	0.76	0.71
C.D.5%	1.55	0.65	N.S.	1.08	N.S.	N.S.	N.S.

Graph-4.3 **Plant height (cm) 30 days as influenced by various treatments and their interaction (I year).**





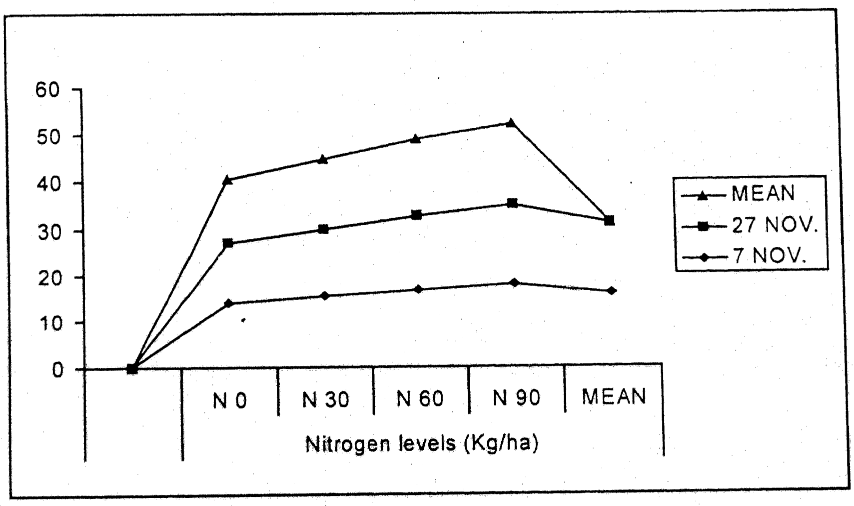


Table 4.4 **Plant height (cm) at 30 days as influenced by various treatments and their interaction (II year)**

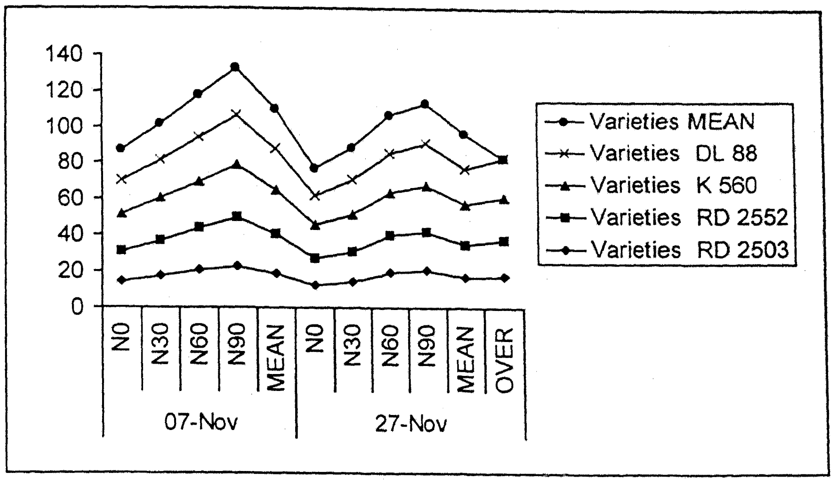
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	14.27	16.68	20.25	18.68	**17.47**
	N_{30}	17.35	19.53	23.32	21.57	**20.44**
	N_{60}	20.27	23.18	26.13	24.74	**23.58**
	N_{90}	22.74	26.68	29.80	27.24	**26.61**
	MEAN	**18.66**	**21.52**	**24.87**	**23.06**	**22.03**
27-Nov	N_0	12.42	14.71	18.36	16.30	**15.45**
	N_{30}	14.28	16.67	20.53	19.42	**17.72**
	N_{60}	19.57	20.34	23.42	22.38	**21.43**
	N_{90}	20.35	21.22	25.73	23.79	**22.77**
	MEAN	**16.65**	**18.23**	**22.01**	**20.47**	**19.34**
OVER ALL MEAN		**17.65**	**19.87**	**23.44**	**21.76**	

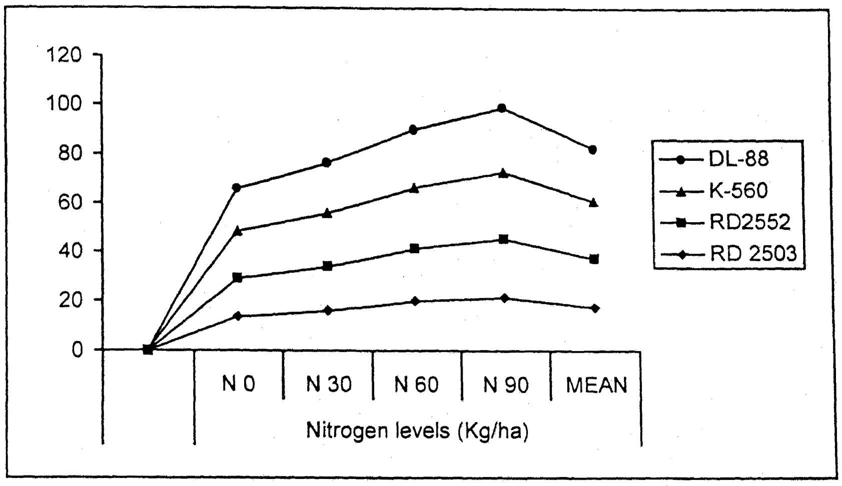
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	13.34	15.81	19.92	21.54	**17.65**
RD2552	15.69	18.1	21.76	23.95	**19.87**
K-560	19.3	21.92	24.77	27.76	**23.44**
DL-88	17.49	20.49	23.56	25.51	**21.76**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	17.47	20.44	23.58	26.61	**22.03**
27 NOV.	15.45	17.72	21.43	22.77	**19.34**
MEAN	**16.46**	**19.08**	**22.5**	**24.69**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.77	0.36	0.72	0.53	1.05	0.74	0.74
C.D. 5%	1.88	0.83	N.S.	1.06	N.S.	N.S.	N.S.

Graph-4.4 **Plant height (cm) at 30 days as influenced by various treatments and their interaction (II year).**





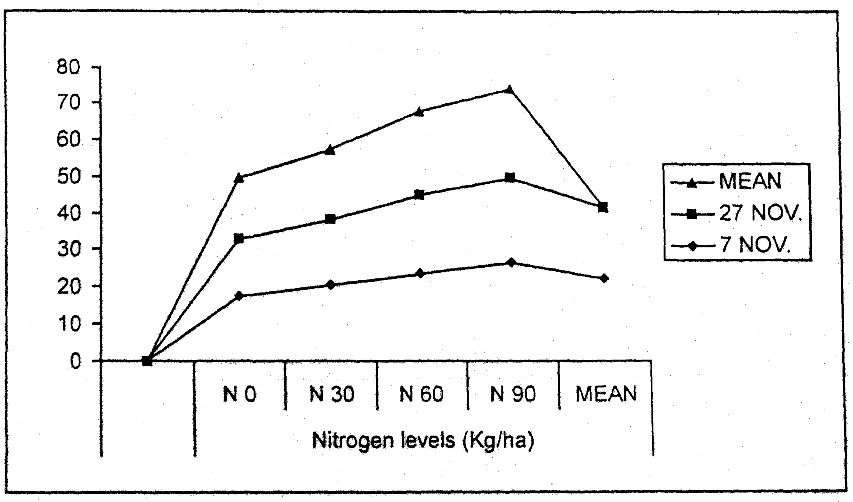


Table 4.5 **Plant height (cm) at 60 days as influenced by various treatments and their interaction (I year)**

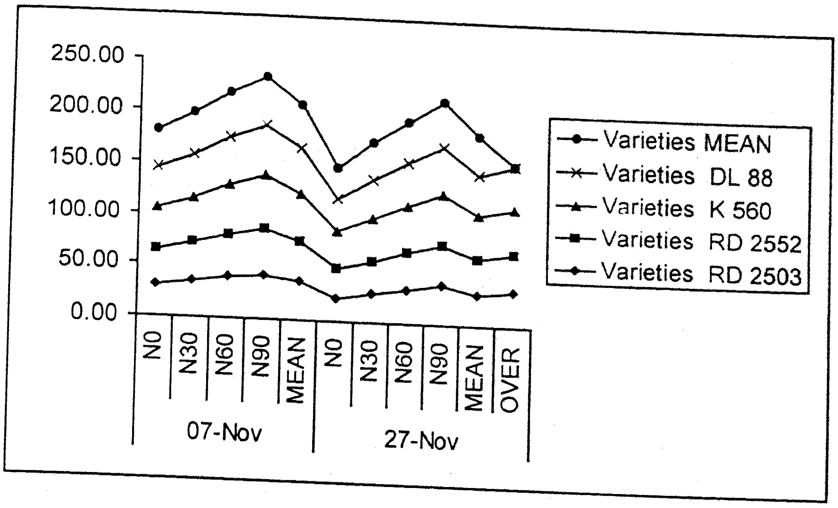
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	30.33	34.23	41.17	38.27	**36.00**
	N_{30}	34.53	37.40	44.30	41.37	**39.40**
	N_{60}	38.43	42.27	48.50	45.43	**43.66**
	N_{90}	41.37	45.70	52.57	47.53	**46.80**
	MEAN	**36.16**	**39.90**	**46.64**	**43.15**	**41.46**
27-Nov	N_0	22.33	28.27	36.17	32.37	**29.78**
	N_{30}	27.66	31.37	42.20	37.93	**34.79**
	N_{60}	32.37	36.37	46.37	41.03	**39.03**
	N_{90}	37.74	39.43	50.57	44.57	**43.08**
	MEAN	**30.02**	**33.86**	**43.83**	**38.97**	**36.67**
OVER ALL MEAN		**33.10**	**36.88**	**45.23**	**41.06**	

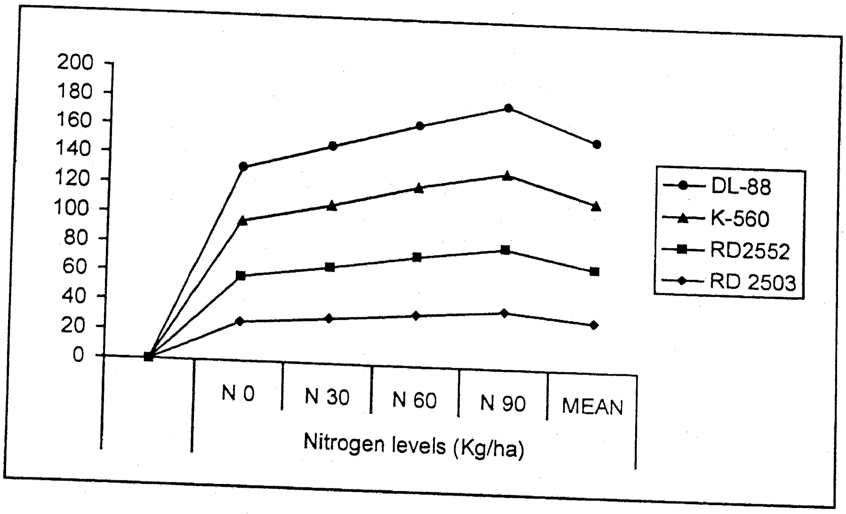
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	26.33	31.09	35.40	39.55	**33.10**
RD2552	31.25	34.38	39.32	42.56	**36.88**
K-560	38.67	43.25	47.43	51.53	**45.23**
DL-88	35.32	39.65	43.23	46.05	**41.06**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	36.00	39.40	43.66	46.80	**41.46**
27 NOV.	29.78	34.79	39.03	43.08	**36.67**
MEAN	**32.89**	**37.09**	**41.34**	**44.94**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.03	0.82	1.64	0.99	1.98	1.40	1.46
C.D. 5%	1.89	1.89	N.S.	1.99	N.S.	N.S.	N.S.

Graph-4.5 **Plant height (cm) at 60 days as influenced by various treatments and their inateraction (I year)**





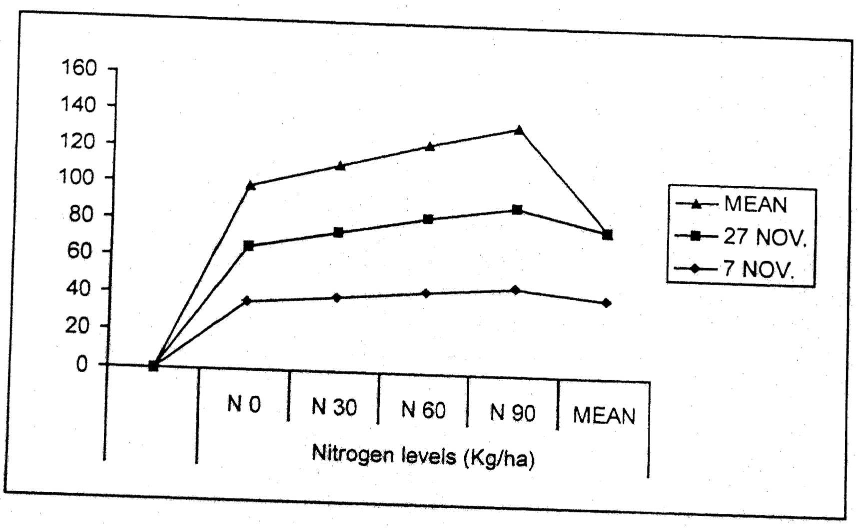


Table 4.6 **Plant height (cm) at 60 days as influenced by various treatments and their interaction (II year)**

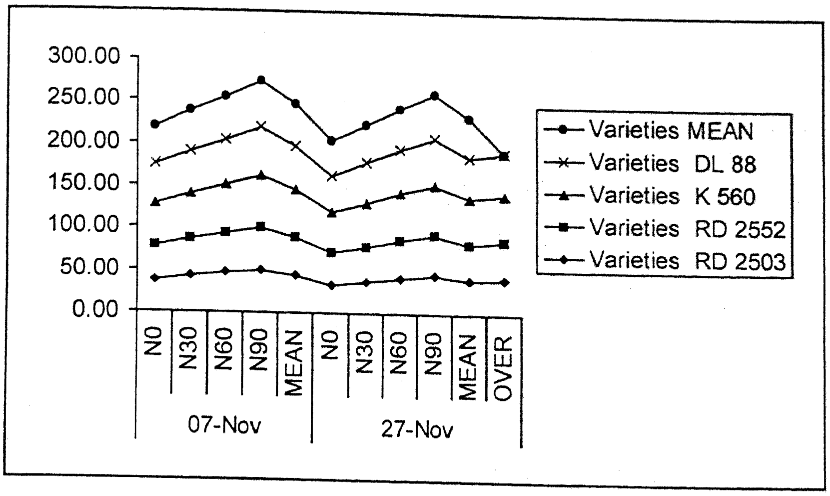
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	37.40	40.47	50.30	46.43	**43.65**
	N_{30}	42.23	44.23	54.40	49.37	**47.57**
	N_{60}	46.60	47.40	57.43	52.33	**50.94**
	N_{90}	49.30	51.43	61.47	56.40	**54.65**
	MEAN	**43.88**	**45.88**	**55.90**	**51.13**	**49.20**
27-Nov	N_0	33.43	38.33	48.63	42.30	**40.67**
	N_{30}	37.33	41.37	52.60	47.47	**44.69**
	N_{60}	41.40	45.23	56.47	50.53	**48.41**
	N_{90}	45.53	48.33	59.40	54.30	**51.89**
	MEAN	**39.42**	**43.31**	**54.27**	**48.65**	**46.41**
OVER ALL MEAN		**41.65**	**44.59**	**55.08**	**49.89**	

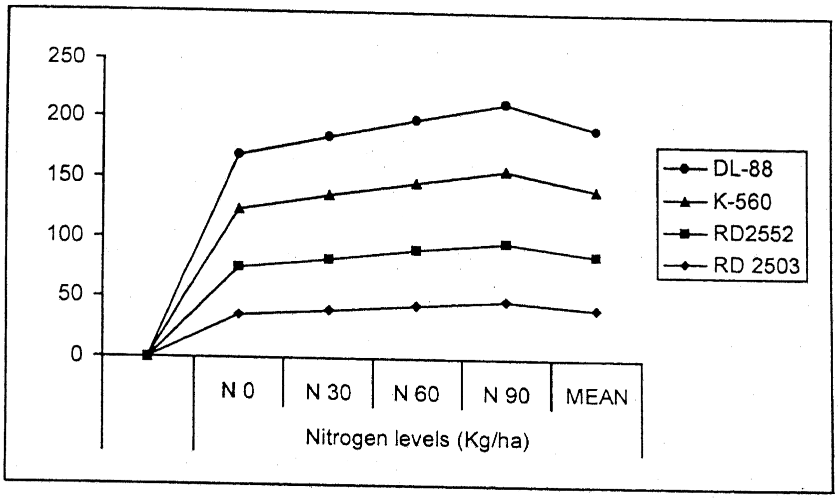
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	35.41	39.78	44.00	47.41	**41.65**
RD2552	39.40	42.80	46.31	49.88	**44.59**
K-560	49.46	53.50	56.95	60.43	**55.08**
DL-88	44.36	48.42	51.43	55.35	**49.89**

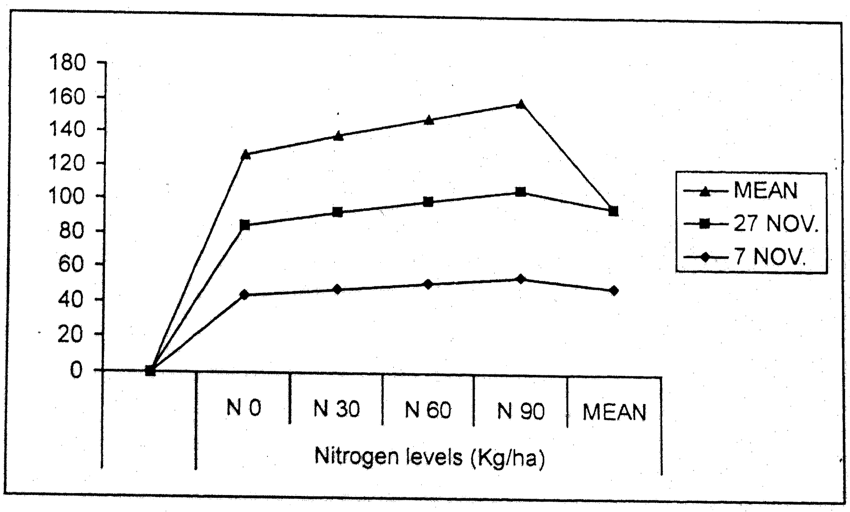
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	43.65	47.57	50.94	54.65	**49.20**
27 NOV.	40.67	44.69	48.41	51.89	**46.41**
MEAN	**42.16**	**46.13**	**49.67**	**53.27**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt.±	0.92	0.28	0.56	0.61	1.22	0.86	0.80
C.D. 5%	2.25	0.64	1.28	1.23	N.S.	N.S.	N.S.

Graph-4.6 **Plant height (cm) at 60 days as influenced by various treatments and their inateraction (II year)**







respective years) as compared to rest of the varieties. This was followed by DL-88. The variety RD 2503 resulted in the lowest height 33.10 cm and 41.65 cm). Late sowing by 20 days discouraged this parameter significantly at this stage also. Increasing N levels increased the plant height significantly. As such, N_{90} recorded the maximum height (44.94 cm in first year and 53.27 cm. in second year), while the lowest values (32.89 and 42.16 cm) were obtained from the control (No) treatment.

4.1.4 Plant height at 90 DAS :

Similar ~~result~~ trend in results was continued at this growth stage also as revealed from Table 4.7 and 4.8. Amongst the varieties, K-560 registered significantly maximum height (87.99 and 93.83 cm in the respective years) over rest of the varieties. This was followed by DL-88 (85.28 and 90.56 cm.). Late sowing by 20 days significantly reduced the plant height. Increasing levels of nitrogen upto N_{90} enhanced the plant height significantly. Accordingly the maximum height was found to be 90.18 and 92.82 cm. in both the years as against the control (No) treatment (78.47 and 84.62 cm.). Amongst the treatment interactions, only NxD interaction was found to be significant in first year only. Accordingly, normal sowing date with N_{90} resulted in maximum plant height over rest of the interactions.

Table 4.7 **Plant height (cm) at 90 days as influenced by various treatments and their interaction (I year)**

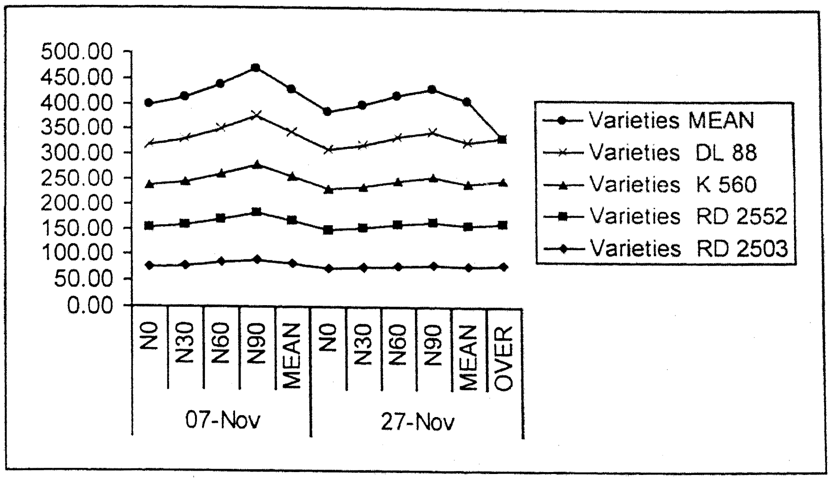
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	75.31	78.37	85.20	80.25	**79.78**
	N_{30}	77.25	81.27	87.17	84.17	**82.46**
	N_{60}	84.15	86.20	90.33	89.33	**87.50**
	N_{90}	90.20	93.40	97.13	95.13	**93.96**
	MEAN	**81.73**	**84.81**	**89.96**	**87.22**	**85.92**
27-Nov	N_0	73.78	76.42	80.32	78.15	**77.17**
	N_{30}	75.23	78.26	83.24	81.36	**79.92**
	N_{60}	78.63	81.83	88.35	85.41	**83.55**
	N_{90}	80.28	84.72	92.18	88.43	**86.40**
	MEAN	**76.98**	**80.31**	**86.02**	**83.34**	**81.66**
OVER ALL MEAN		**79.35**	**82.56**	**87.99**	**85.28**	

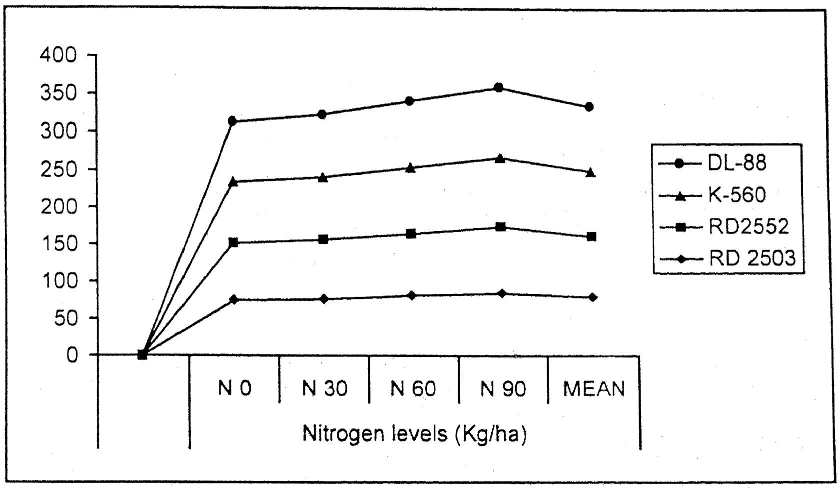
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	74.54	76.24	81.39	85.24	**79.35**
RD2552	77.39	79.76	84.01	89.06	**82.56**
K-560	82.76	85.20	89.34	94.65	**87.99**
DL-88	79.20	82.76	87.37	91.78	**85.28**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	79.78	82.46	87.50	93.96	**85.92**
27 NOV.	77.17	79.92	83.55	86.40	**81.66**
MEAN	**78.47**	**81.19**	**85.52**	**90.18**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.46	0.36	0.72	0.63	1.26	0.89	0.85
C.D. 5%	1.11	0.83	N.S.	1.26	N.S.	1.79	N.S.

Graph-4.7 **Plant height (cm) at 90 days as influenced by various treatments and their inateraction (I year)**





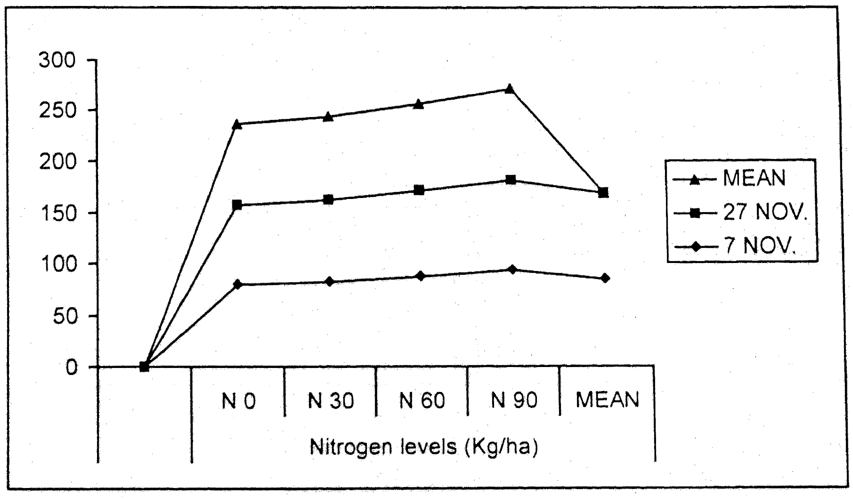


Table 4.8 **Plant height (cm) at 90 days as influenced by various treatments and their interaction (IInd year)**

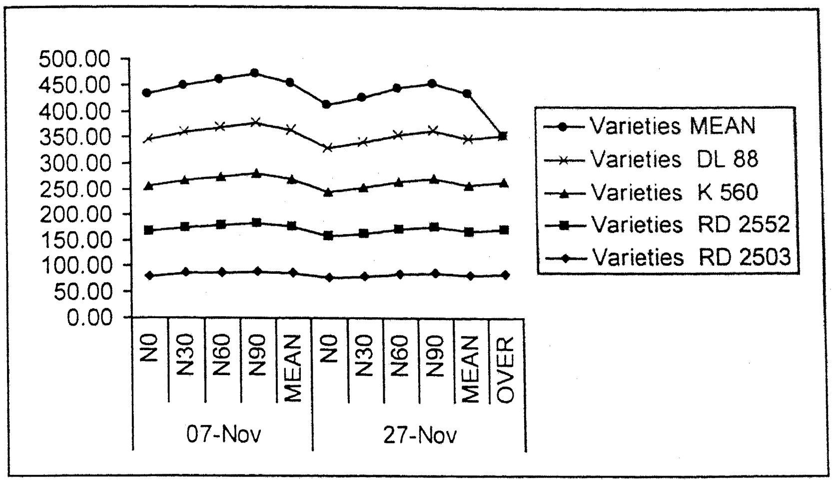
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	81.14	85.15	91.35	89.12	**86.69**
	N_{30}	86.10	88.37	94.23	91.39	**90.02**
	N_{60}	88.22	90.08	97.09	94.22	**92.40**
	N_{90}	90.11	93.23	99.12	96.15	**94.65**
	MEAN	**86.39**	**89.21**	**95.45**	**92.72**	**90.94**
27-Nov	N_0	77.36	80.27	88.40	84.18	**82.55**
	N_{30}	80.24	83.31	90.55	87.38	**85.37**
	N_{60}	85.07	86.76	93.30	90.33	**88.86**
	N_{90}	87.22	88.43	96.64	91.73	**91.00**
	MEAN	**82.47**	**84.69**	**92.22**	**88.40**	**86.95**
OVER ALL MEAN		**84.63**	**86.95**	**93.83**	**90.56**	

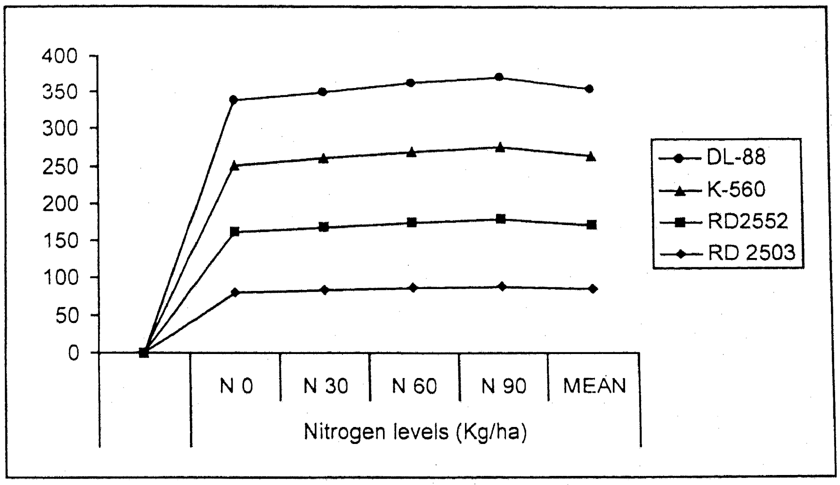
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	79.25	83.17	86.65	88.67	**84.43**
RD2552	82.71	85.84	88.42	90.83	**86.95**
K-560	89.87	92.39	95.20	97.88	**93.83**
DL-88	86.65	89.38	92.28	93.94	**90.56**

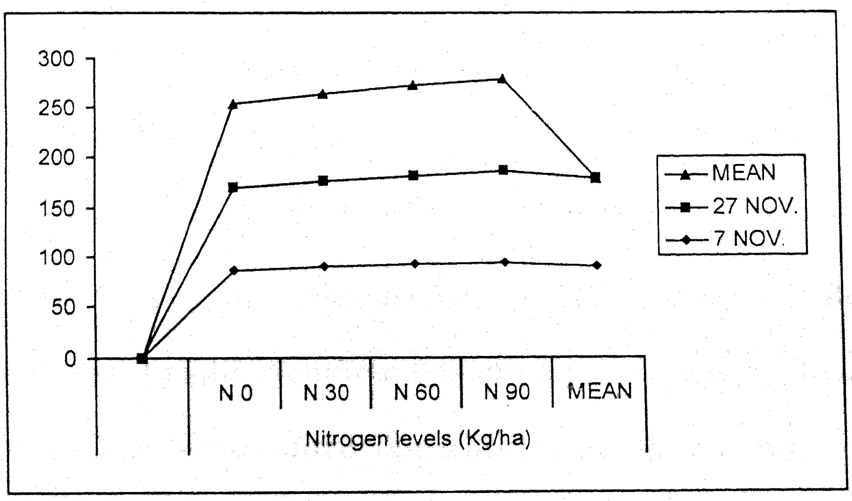
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	86.69	90.02	92.40	94.65	**90.94**
27 NOV.	82.55	85.37	88.86	91.00	**86.95**
MEAN	**78.47**	**81.19**	**85.52**	**90.18**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.55	0.39	0.79	0.70	1.39	0.98	0.94
C.D. 5%	1.35	0.91	N.S.	1.40	N.S.	N.S.	N.S.

Graph-4.8 **Plant height (cm) at 90 days as influenced by various treatments and their inateraction (II year)**







4.1.5 Plant height at maturity :

The enhancement in plant height between 90 DAS till maturity stage was, in general, very slight in all the treatments in both the years (Table 4.9 and 4.10). None of the treatment interactions exerted significant influence upon this parameter at this last stage of observation. However, only the separate effect of the treatments continued to be significant. As such, the variety K-560 recorded maximum 92.39 cm height in first year and 97.67 cm in the second year. RD-2503 continued to be the dwarfest one. Late sowing by 20 days reduced the height significantly. Similarly increasing N levels augmented the height significantly. Thus, at N_{90} level, the maximum height was 92.32 and 99.33 cm. in the respective years.

4.1.6 Plant height at different growth ~~intervals:~~ stages

The summary Table 4.11 reveals that the plant height was enhanced steadily with the advancement of plant growth till maturity stage.

The plant height ranged from 15.45 to 20.76 cm at 30 days stage to 86.21 to 92.96 cm at maturity stage. K-560 proved the tallest one at every stage. This was followed by DL-88, while RD 2503 proved to be the dwarfest one. Late sowing by 20 days discouraged the height significantly whereas increasing levels of nitrogen upto N_{90} encouraged this parameter significantly at every

Table 4.9 **Plant height (cm) at maturity as influenced by various treatments and their interaction (I year)**

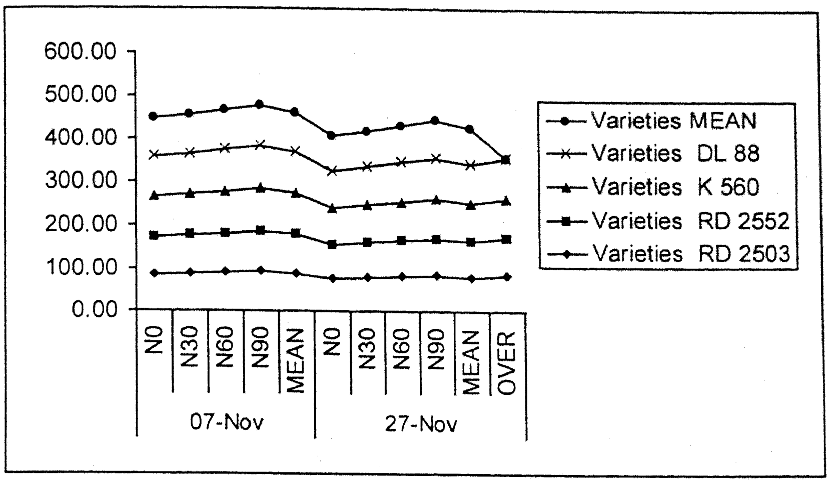
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	85.52	88.37	93.67	90.59	**89.54**
	N_{30}	87.38	90.42	94.30	92.47	**91.14**
	N_{60}	90.09	92.58	96.36	94.32	**93.34**
	N_{90}	92.27	95.77	98.17	96.27	**95.62**
	MEAN	**88.81**	**91.78**	**95.62**	**93.41**	**92.40**
27-Nov	N_0	76.12	80.07	85.46	83.22	**81.22**
	N_{30}	79.63	82.25	87.74	85.76	**83.84**
	N_{60}	81.38	85.42	90.32	88.48	**86.40**
	N_{90}	84.15	87.49	93.12	91.38	**89.03**
	MEAN	**80.32**	**83.81**	**89.16**	**87.21**	**85.12**
OVER ALL MEAN		**84.56**	**87.79**	**92.39**	**90.31**	

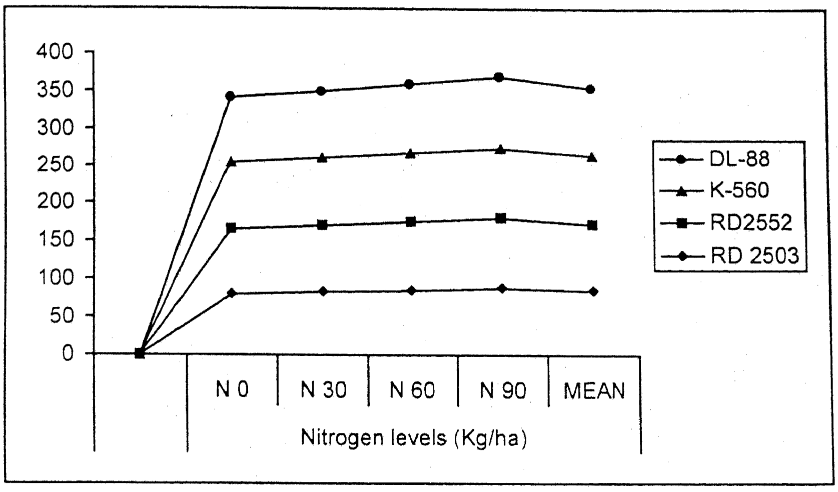
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	80.82	83.50	85.73	88.21	**84.56**
RD2552	84.22	86.33	89.00	91.63	**87.79**
K-560	89.56	91.02	93.34	95.64	**92.39**
DL-88	86.90	89.11	91.40	93.82	**90.31**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	89.54	91.14	93.34	95.62	**92.40**
27 NOV.	81.22	83.84	86.40	89.03	**85.12**
MEAN	**85.38**	**87.49**	**89.87**	**92.32**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	2.23	1.51	3.02	2.42	4.85	3.43	3.33
C.D. 5%	5.45	3.48	N.S.	4.87	N.S.	N.S.	N.S.

Graph-4.9 Plant height (cm) at maturity as influenced by various treatments and their inateraction (I year)





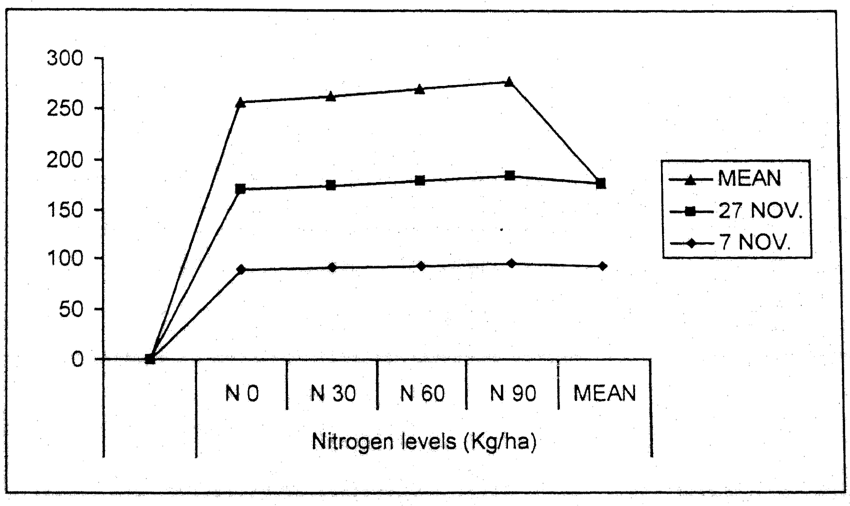


Table 4.10 **Plant height (cm) at maturity as influenced by various treatments and their interaction (II year)**

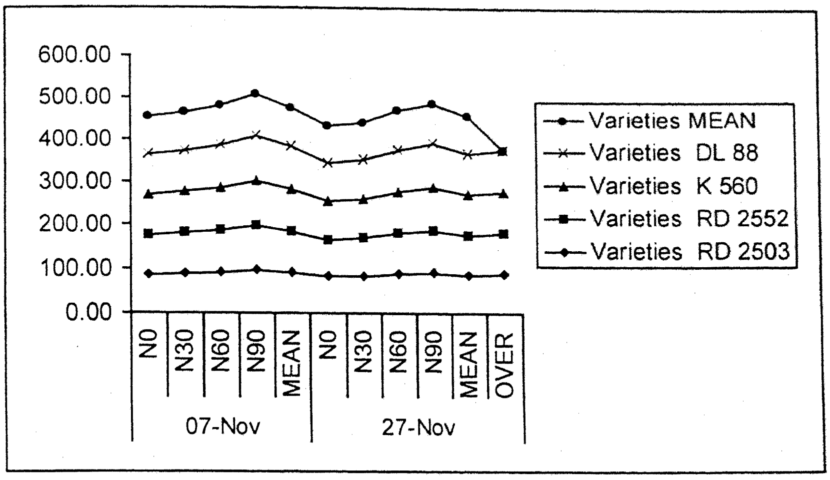
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	85.20	90.63	94.86	92.71	**90.85**
	N_{30}	88.33	92.48	96.76	94.65	**93.05**
	N_{60}	90.47	96.55	100.15	98.34	**96.38**
	N_{90}	96.67	101.21	105.25	103.46	**101.65**
	MEAN	**90.17**	**95.22**	**99.25**	**97.29**	**95.48**
27-Nov	N_0	81.44	84.29	90.42	88.70	**86.21**
	N_{30}	83.52	86.36	92.56	90.47	**88.23**
	N_{60}	87.18	93.43	98.74	96.28	**93.91**
	N_{90}	90.07	96.58	102.63	100.38	**97.41**
	MEAN	**85.55**	**90.16**	**96.09**	**93.96**	**91.44**
OVER ALL MEAN		**87.86**	**92.69**	**97.67**	**95.62**	

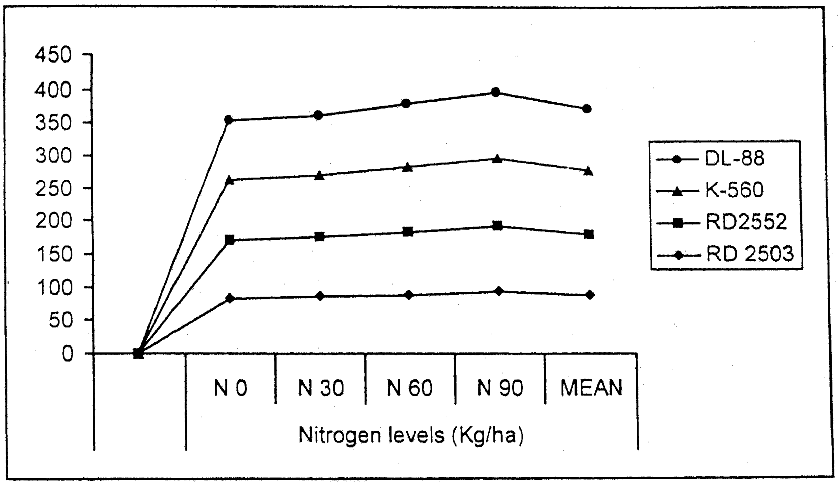
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	83.32	85.92	88.82	93.37	**87.86**
RD2552	87.46	89.42	94.99	98.89	**92.69**
K-560	92.64	94.66	99.44	103.94	**97.67**
DL-88	90.70	92.56	97.31	101.92	**95.62**

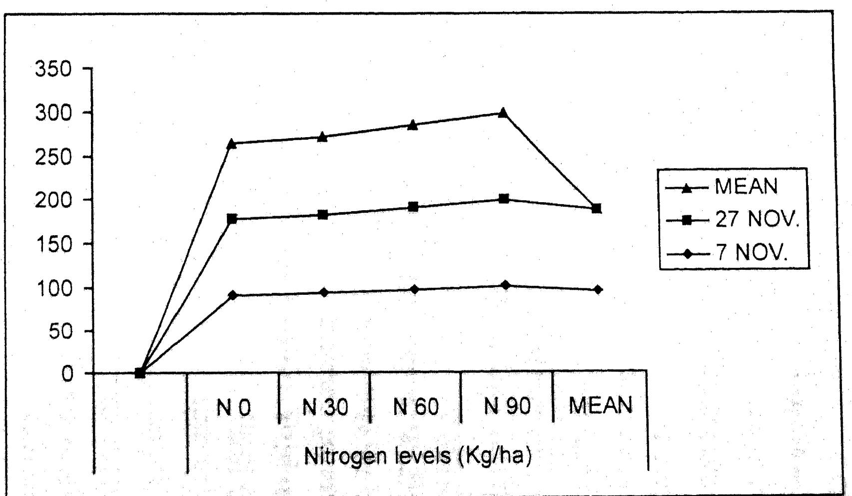
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	90.85	93.05	96.38	101.65	**95.48**
27 NOV.	86.21	88.23	93.91	97.41	**91.44**
MEAN	**88.53**	**90.64**	**95.14**	**99.53**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt.±	0.73	0.83	1.66	0.55	1.11	0.78	1.07
C.D. 5%	1.79	1.92	N.S.	1.11	N.S.	N.S.	N.S.

Graph-4.10 **Plant height (cm) at maturity as influenced by various treatments and their inateraction (II year)**







Summary table 4.11

Plant height (cm) as influenced by various treatments and their interactions

Treatments	Plant height (cm) at different growth ~~interval~~ stages											
Main plot treatments	**30 Days**			**60 Days**			**90 Days**			**Maturity**		
Varieties	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**
V_1-(R.D.2503)	13.26	17.65	**15.45**	33.10	41.65	**37.37**	79.35	84.43	**81.89**	84.56	87.86	**86.21**
V_2-(R.D.2552)	14.54	19.87	**17.20**	36.88	44.59	**40.73**	82.56	86.95	**84.75**	87.79	92.69	**90.24**
V_3-(K.560)	18.08	23.44	**20.76**	45.23	55.08	**50.15**	87.99	93.83	**90.91**	92.39	97.67	**95.03**
V_4-(DL.88)	16.17	21.76	**18.96**	41.06	49.89	**45.47**	85.28	90.56	**87.92**	90.31	95.62	**92.96**
C.D.(5%)	01.55	01.88	**01.71**	02.52	02.25	**02.38**	01.12	01.35	**01.23**	05.45	01.79	**03.62**
Sub plot treatments												
Date of sowing												
D_1-(7th November)	16.08	22.03	**19.05**	41.46	49.20	**45.33**	85.92	90.94	**88.43**	92.40	95.48	**93.94**
D_2-(27th November)	14.95	19.34	**17.14**	36.67	46.41	**41.54**	81.66	86.95	**84.30**	85.12	91.44	**88.28**
C.D.(5%)	00.65	00.83	**00.74**	01.89	00.64	**01.26**	00.83	00.91	**00.87**	03.48	01.92	**02.70**
Sub sub plot treatments												
Nitrogen levels (Kg/ha.)												
N_1-(Control)	13.51	16.46	**14.98**	32.89	42.16	**37.52**	78.47	78.47	**78.47**	85.38	88.53	**86.95**
N_2-(30 Kg/ha.)	14.88	19.08	**16.98**	37.09	46.13	**41.61**	81.19	81.19	**81.19**	87.49	90.64	**89.06**
N_3-(60 Kg/ha.)	16.29	22.50	**19.39**	41.34	49.67	**45.50**	85.52	85.52	**85.52**	89.87	95.14	**92.50**
N_4-(90 Kg/ha.)	17.38	24.69	**21.03**	44.94	53.27	**49.10**	90.18	90.18	**90.18**	92.32	99.53	**95.92**
C.D.(5%)	01.08	01.06	**01.07**	01.99	01.23	**01.61**	01.26	01.40	**01.33**	04.87	01.11	**02.99**
Interaction												
VxD	N.S.	N.S.		N.S.	01.28		N.S.	N.S.		N.S.	N.S.	
VxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
DxN	N.S.	N.S.		N.S.	N.S.		01.79	N.S.		N.S.	N.S.	
VxDxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	

stage of plant growth. The treatment interactions were found to be almost non-significant at every stage.

4.1.7 No. of tillers/running meter at 60 DAS :

be d

This parameter was found to influence significantly only due to separate effect of treatments, the treatment interactions exerted no influence (Table 4.12 and 4.13). R.D. 2552 attained almost significantly higher tiller number (145.87 in first year and 189.29 in second year) over rest of the varieties. RD 2503 registered the lowest tiller number (80.37 and 128.37 in respective years). K-560 proved the second best in this parameter. Late sown crop resulted in significantly lower tiller number over the normal sown crop. Increasing levels of nitrogen upto N_{90} significantly increased the tiller number. Thus, the maximum tiller number was 142.0 in first year and 180.25 in second year in case of N_{90} . On the other hand, the lowest value (90.46 and 139.87 tillers in respective years) was recorded in case of no nitrogen (No)

4.1.8 No. of tillers/running meter at 90 DAS :

in result

The similar result trend was continued at 90 days stage of plant growth as indicated in Table 4.14 and 4.15 RD 2552 recorded highest tiller number (144.12 in first year and 187.71 in second year), being significantly superior to rest of the varieties. K-560 stood the second best in this regard. R.D. 2503 recorded the lowest value (78.54 and 126.58 in the respective years).

Table 4.12 No. of tillers/running meter at 60 days as influenced by various treatments and their interaction (I year)

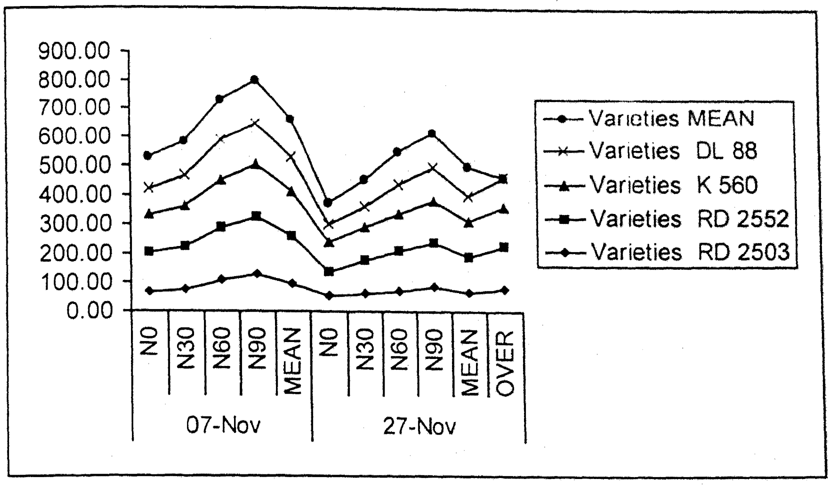
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	65.33	138.33	130.33	88.00	**105.50**
	N_{30}	73.67	150.33	140.67	101.00	**116.42**
	N_{60}	107.67	183.00	161.33	132.33	**146.08**
	N_{90}	126.33	200.33	175.67	140.00	**160.58**
	MEAN	**93.25**	**168.00**	**152.00**	**115.33**	**132.14**
27-Nov	N_0	53.67	83.33	104.00	60.67	**75.42**
	N_{30}	61.00	116.67	115.33	70.00	**90.75**
	N_{60}	70.00	142.00	126.67	99.67	**109.58**
	N_{90}	85.33	153.00	143.67	111.67	**123.42**
	MEAN	**67.75**	**123.75**	**122.42**	**85.50**	**99.81**
OVER ALL MEAN		**80.37**	**145.87**	**137.21**	**100.41**	

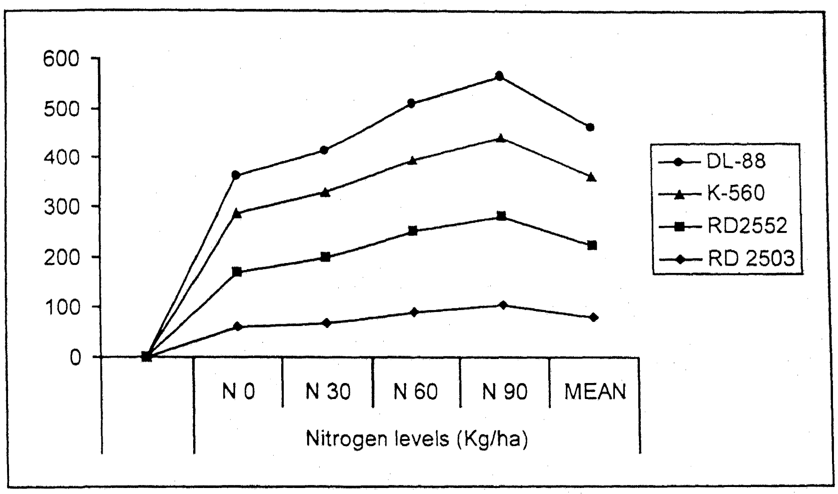
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	59.50	67.33	88.83	105.83	**80.37**
RD2552	110.83	133.50	162.50	176.67	**145.87**
K-560	117.16	128.00	144.00	159.67	**137.21**
DL-88	74.33	85.50	116.00	125.84	**100.41**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	105.50	116.42	146.08	160.58	**132.14**
27 NOV.	75.42	90.75	109.58	123.42	**99.81**
MEAN	**90.46**	**103.58**	**127.83**	**142.00**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	3.70	3.50	6.98	6.31	12.63	8.93	8.48
C.D. 5%	9.13	8.04	N.S.	12.69	N.S.	N.S.	N.S.

Graph-4.12 **No. of tillers/running metre at 60 days as influenced by various treatments and their inateraction (I year)**





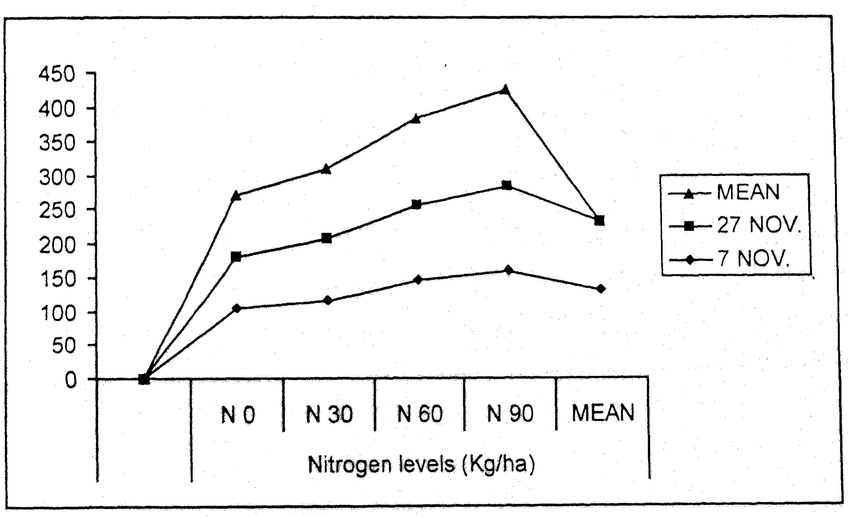


Table 4.13 No. of tillers/running meter at 60 days as influenced by various treatments and their interaction (II year)

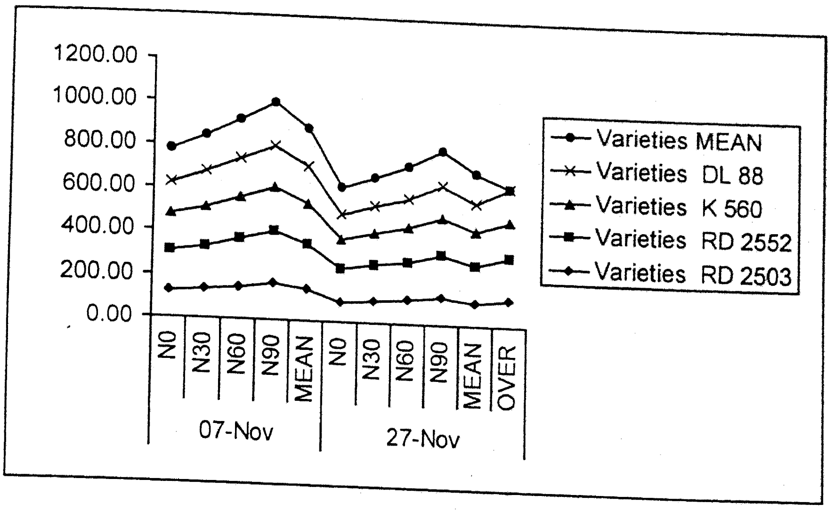
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	124.67	183.33	168.33	145.67	**155.50**
	N_{30}	136.67	195.67	180.00	162.33	**168.67**
	N_{60}	151.33	217.67	192.00	176.00	**184.25**
	N_{90}	172.33	232.67	206.67	188.00	**199.92**
	MEAN	**146.25**	**207.33**	**186.75**	**168.00**	**177.08**
27-Nov	N_0	92.67	154.00	135.00	115.33	**124.25**
	N_{30}	104.33	164.33	145.67	125.00	**134.83**
	N_{60}	113.33	175.33	156.67	135.00	**145.08**
	N_{90}	131.67	191.33	170.00	149.33	**160.58**
	MEAN	**110.50**	**171.25**	**151.84**	**131.16**	**141.19**
	OVER ALL MEAN	**128.37**	**189.29**	**169.29**	**149.58**	

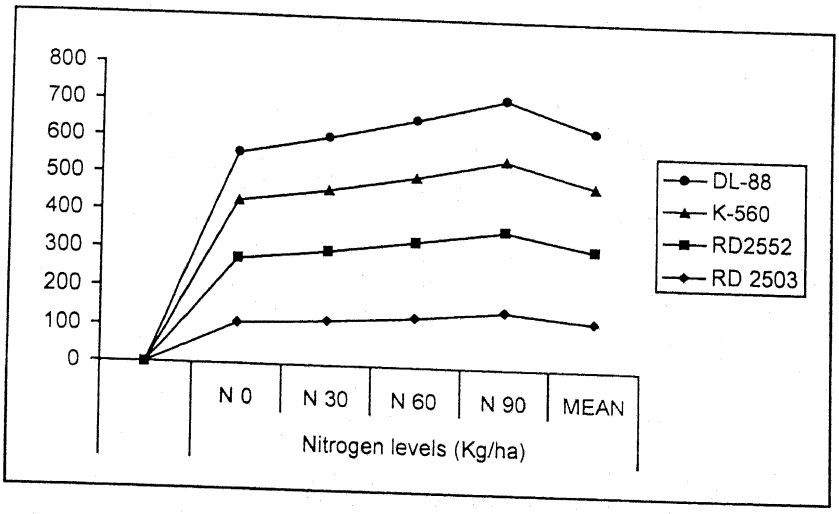
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	108.67	120.50	132.33	152.00	**128.37**
RD2552	168.67	180.00	196.50	212.00	**189.29**
K-560	151.67	162.83	174.33	188.34	**169.29**
DL-88	130.50	143.67	155.50	168.67	**149.58**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	155.50	168.67	184.25	199.92	**177.08**
27 NOV.	124.25	134.83	145.08	160.58	**141.19**
MEAN	**139.87**	**151.75**	**164.67**	**180.25**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	4.54	2.74	5.48	4.30	8.62	6.09	5.95
C.D. 5%	11.12	6.32	N.S.	8.66	N.S.	N.S.	N.S.

Graph-4.13 **No. of tillers/running metre at 60 days as influenced by various treatments and their inateraction (II year)**





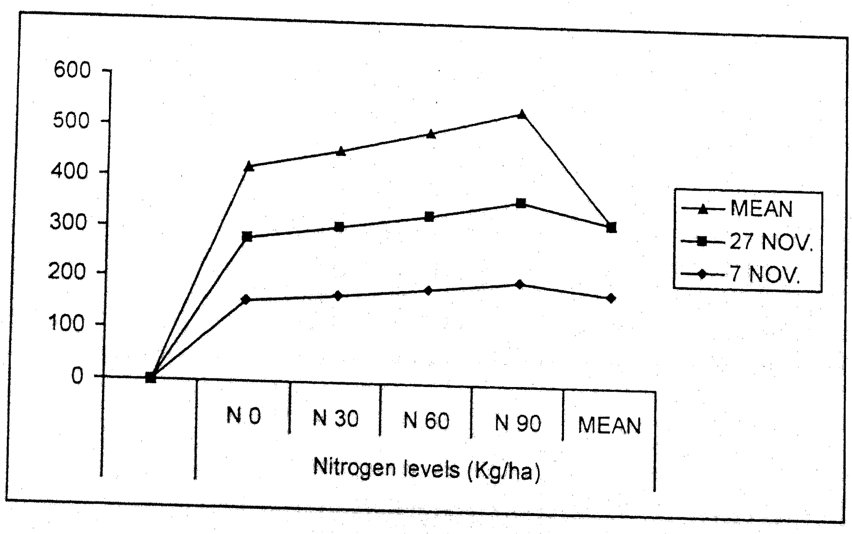


Table 4.14 No. of tillers/running meter at 90 days as influenced by various treatments and their interaction (I year)

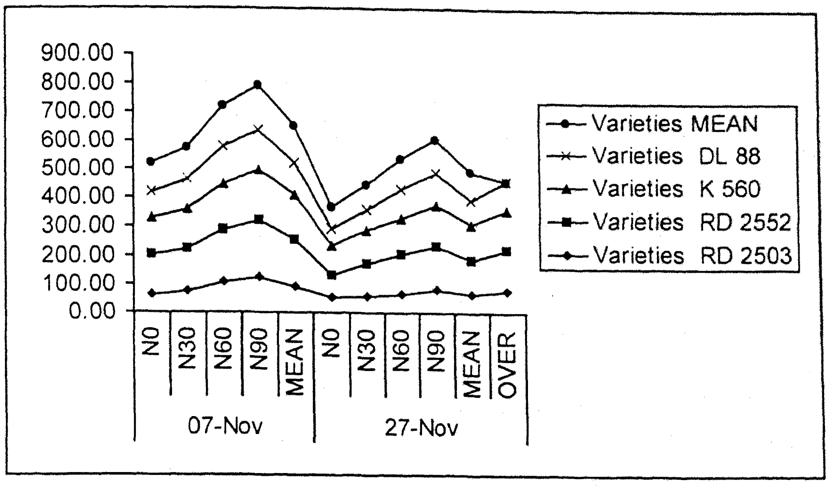
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	63.67	137.00	129.00	86.00	**103.92**
	N_{30}	72.67	148.33	139.67	99.67	**115.08**
	N_{60}	106.33	180.67	159.33	130.33	**144.16**
	N_{90}	124.00	199.00	174.00	138.00	**158.75**
	MEAN	**91.67**	**166.25**	**150.50**	**113.50**	**130.48**
27-Nov	N_0	52.00	81.67	102.33	59.00	**73.75**
	N_{30}	59.67	115.33	113.67	69.00	**89.42**
	N_{60}	67.00	140.00	124.67	98.33	**107.50**
	N_{90}	83.00	151.00	141.33	110.33	**121.41**
	MEAN	**65.42**	**122.00**	**120.50**	**84.16**	**98.02**
	OVER ALL MEAN	**78.54**	**144.12**	**135.50**	**98.83**	

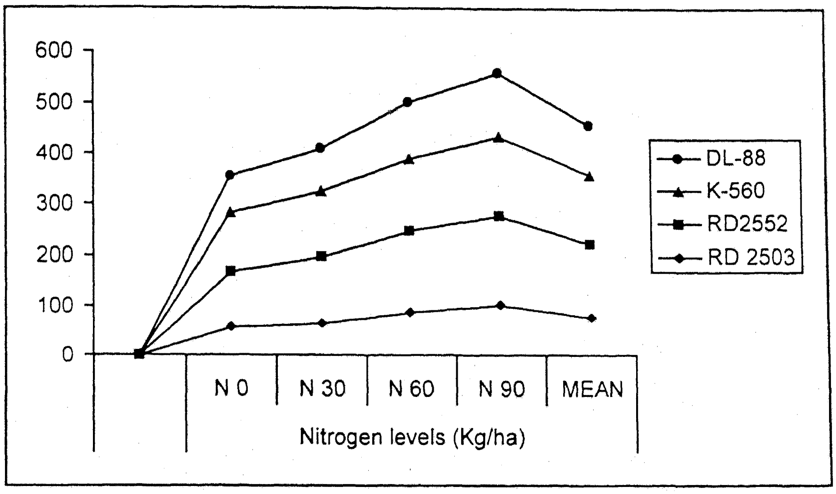
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	57.83	66.17	86.67	103.50	**78.54**
RD2552	109.33	131.83	160.33	175.00	**144.12**
K-560	115.67	126.67	142.00	157.67	**135.50**
DL-88	72.50	84.33	114.33	124.16	**98.83**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	103.92	115.08	144.16	158.75	**130.48**
27 NOV.	73.75	89.42	107.50	121.41	**98.02**
MEAN	**88.83**	**102.25**	**125.83**	**140.08**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	3.99	3.49	6.99	6.29	12.59	8.91	8.47
C.D. 5%	9.75	8.07	N.S.	12.66	N.S.	N.S.	N.S.

Graph-4.14 No. of tillers/running metre at 90 days as influenced by various treatments and their inateraction (I year)





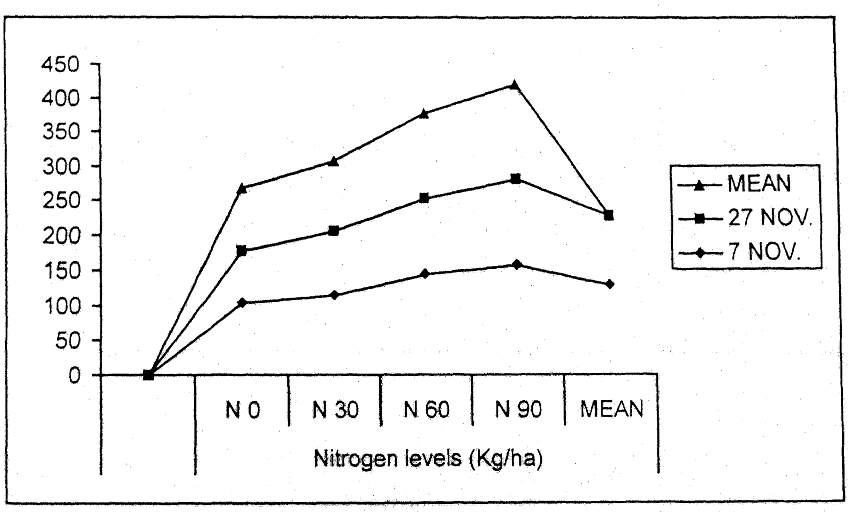


Table 4.15 No. of tillers/running meter at 90 days as influenced by various treatments and their interaction (II year)

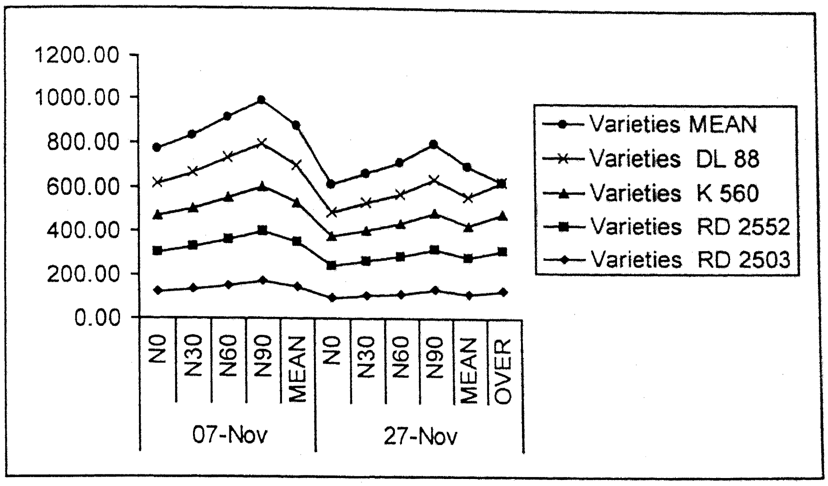
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	122.67	181.33	167.00	144.33	**153.83**
	N_{30}	134.67	193.67	178.00	160.67	**166.75**
	N_{60}	149.67	215.67	190.67	174.67	**182.67**
	N_{90}	169.67	231.67	205.33	186.00	**198.17**
	MEAN	**144.17**	**205.59**	**185.25**	**166.42**	**175.36**
27-Nov	N_0	91.00	152.67	133.67	114.00	**122.84**
	N_{30}	103.00	162.67	144.33	123.00	**133.25**
	N_{60}	112.00	174.00	155.30	133.33	**143.67**
	N_{90}	130.00	190.00	169.00	148.00	**159.25**
	MEAN	**109.00**	**169.84**	**150.58**	**129.58**	**139.75**
	OVER ALL MEAN	**126.58**	**187.71**	**167.92**	**148.00**	

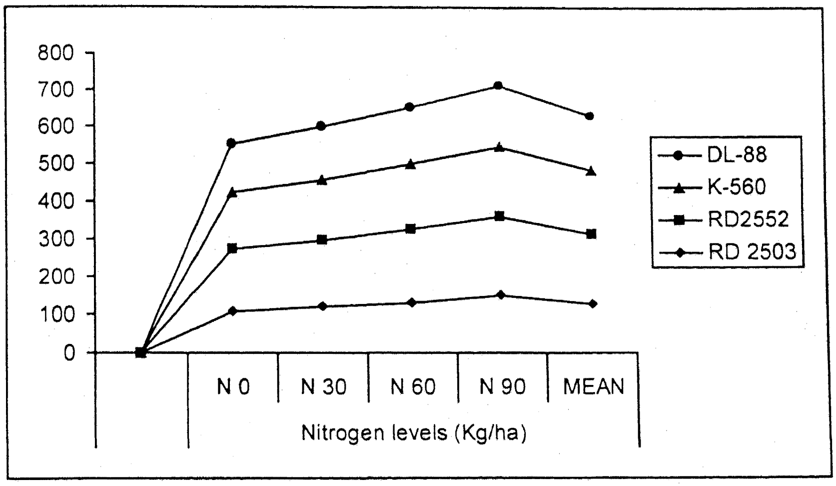
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	106.83	118.83	130.84	149.83	**126.58**
RD2552	167.00	178.17	194.84	210.83	**187.71**
K-560	150.33	161.16	173.00	187.17	**167.92**
DL-88	129.16	141.83	154.00	167.00	**148.00**

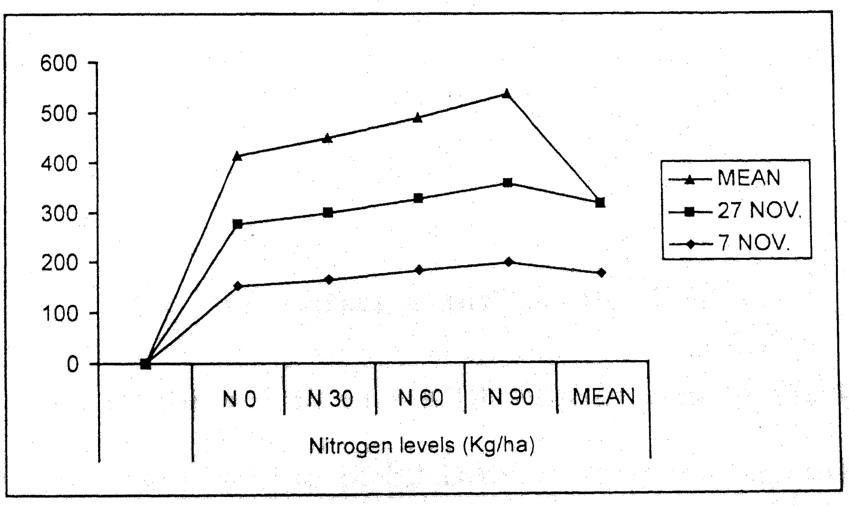
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	153.83	166.75	182.67	198.17	**175.36**
27 NOV.	122.84	133.25	143.67	159.25	**139.75**
MEAN	**138.33**	**150.00**	**163.17**	**178.71**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	3.86	1.93	3.87	4.23	8.46	5.98	5.53
C.D. 5%	9.46	4.47	N.S.	8.51	N.S.	N.S.	N.S.

Graph-4.15 **No. of tillers/running metre at 90 days as influenced by various treatments and their inateraction (II year)**







Normal sowing date recorded 130.48 and 175.36 tillers/running meter in respective years, while late sowing by 20 days resulted in 98.02 and 139.75 tillers respectively. Similarly, increasing N levels upto N_{90} proved highly beneficial in enhancing this characters. As such N_{90} gave significantly higher values (140.08 tillers in first year and 178.71 tillers in the second year). Over rest of the N levels. The treatment interactions exerted no significant influence upon this character.

4.1.9 No. of tillers/plant at 30 DAS :

The tiller number was found to deviate significantly only among the varieties, sowing dates and N-levels, however their interactions did not exert any significant influence during both the years (Table 4.16 and 4.17). Among the varieties RD 2552 and K-560 recorded equally higher tiller number over RD 2503 and DL-88. The tiller number was 3.91 to 4.29/plant in first year and 4.21 to 4.58/plant in second year. The lowest value (2.87 and 3.25/plant) was obtained in case of RD 2503. Sowing dates discouraged while N levels encouraged this parameter significantly. Increasing N levels increased tillers number almost significantly in both the years.

4.1.10 No. of tillers/plant at 60 DAS :

The data in Table 4.18 and 4.19 indicate almost the similar result trend as noted in case of 30 DAS. Among the varieties, RD

Table 4.16 No. of tillers/plant at 30 days as influenced by various treatments and their interaction (I year)

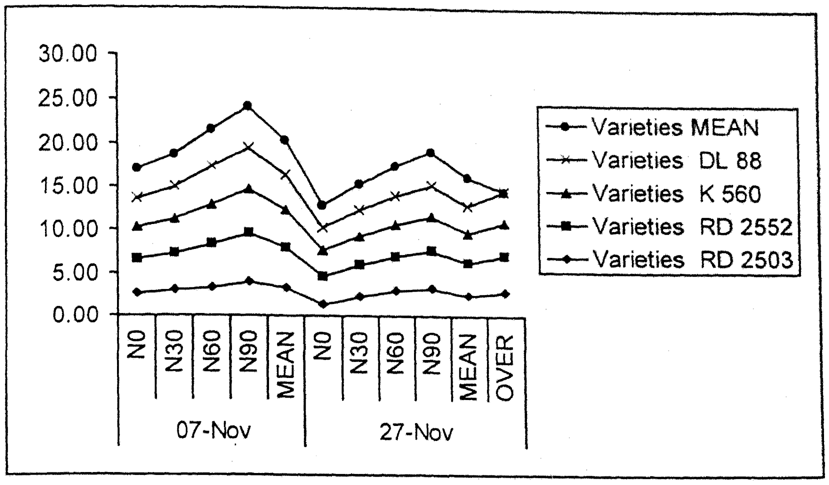
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	2.67	4.00	3.67	3.33	**3.42**
	N_{30}	3.00	4.33	4.00	3.67	**3.75**
	N_{60}	3.33	5.00	4.67	4.33	**4.33**
	N_{90}	4.00	5.67	5.00	4.67	**4.83**
	MEAN	**3.25**	**4.75**	**4.33**	**4.00**	**4.08**
27-Nov	N_0	1.33	3.33	3.00	2.67	**2.58**
	N_{30}	2.33	3.67	3.33	3.00	**3.08**
	N_{60}	3.00	4.00	3.67	3.33	**3.50**
	N_{90}	3.33	4.33	4.00	3.67	**3.83**
	MEAN	**2.50**	**3.83**	**3.50**	**3.17**	**3.25**
	OVER ALL MEAN	**2.87**	**4.29**	**3.91**	**3.58**	

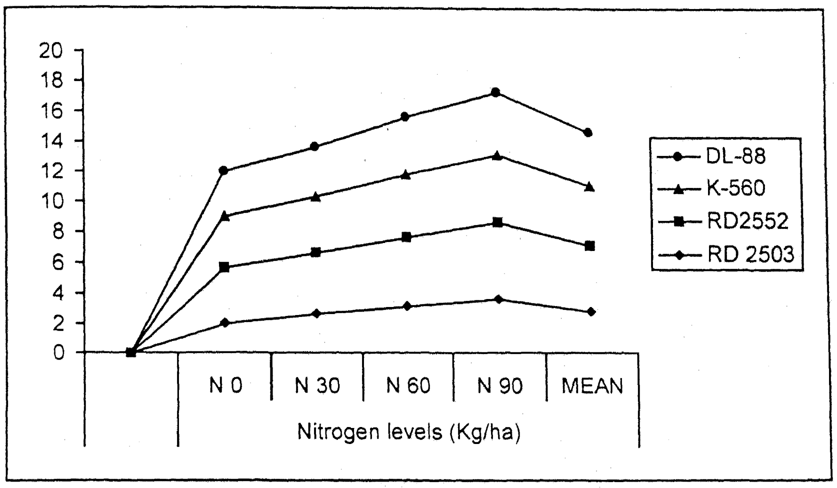
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	2.00	2.67	3.16	3.67	**2.87**
RD2552	3.67	4.00	4.50	5.00	**4.29**
K-560	3.33	3.66	4.17	4.50	**3.91**
DL-88	3.00	3.33	3.83	4.17	**3.58**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	3.42	3.75	4.33	4.83	**4.08**
27 NOV.	2.58	3.08	3.50	3.83	**3.25**
MEAN	**3.00**	**3.41**	**3.91**	**4.33**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.18	0.12	0.20	0.20	0.41	0.29	0.27
C.D. 5%	0.45	0.23	N.S.	0.41	N.S.	N.S.	N.S.

Graph-4.16 No. of tillers/plant at 30 days as influenced by various treatments and their inateraction (I year)





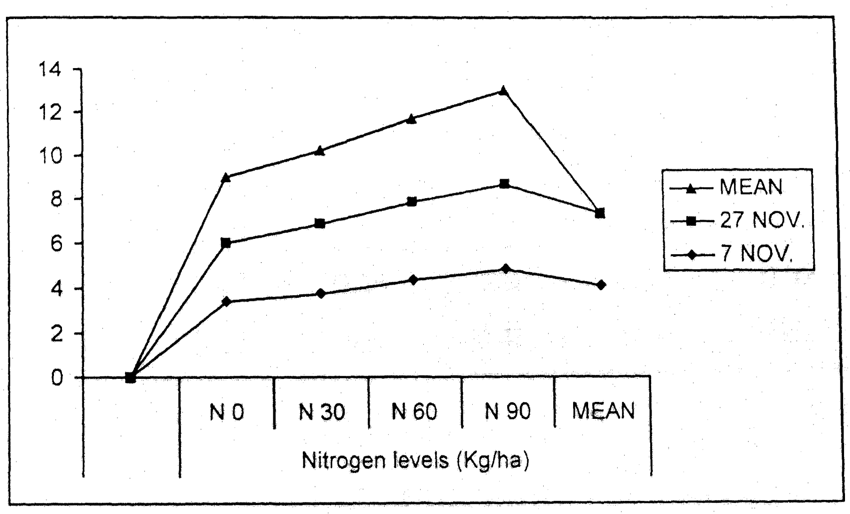


Table 4.17 **No. of tillers/plant at 30 days as influenced by various treatments and their interaction (IInd year)**

Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	3.00	4.33	4.00	3.67	**3.75**
	N_{30}	3.33	4.67	4.33	4.00	**4.08**
	N_{60}	3.67	5.33	4.67	4.33	**4.50**
	N_{90}	4.33	5.67	5.33	4.67	**5.00**
	MEAN	**3.58**	**5.00**	**4.58**	**4.17**	**4.33**
27-Nov	N_0	2.33	3.67	3.33	3.00	**3.08**
	N_{30}	2.67	4.00	3.67	3.33	**3.42**
	N_{60}	3.33	4.33	4.00	3.67	**3.83**
	N_{90}	3.67	4.67	4.33	4.00	**4.17**
	MEAN	**3.00**	**4.17**	**3.83**	**3.50**	**3.62**
	OVER ALL MEAN	**3.29**	**4.58**	**4.21**	**3.83**	

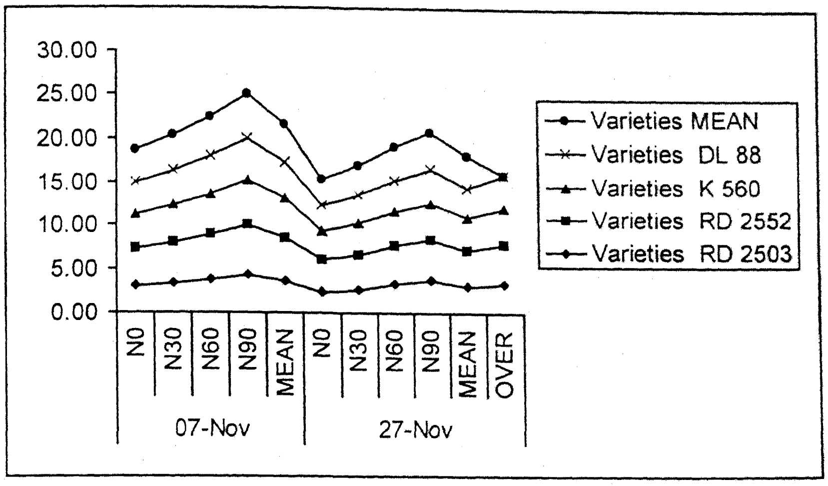
Varieties	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	2.67	3.00	3.50	4.00	**3.29**
RD2552	4.00	4.33	4.83	5.17	**4.58**
K-560	3.67	4.00	4.34	4.84	**4.21**
DL-88	3.33	3.67	4.00	4.34	**3.83**

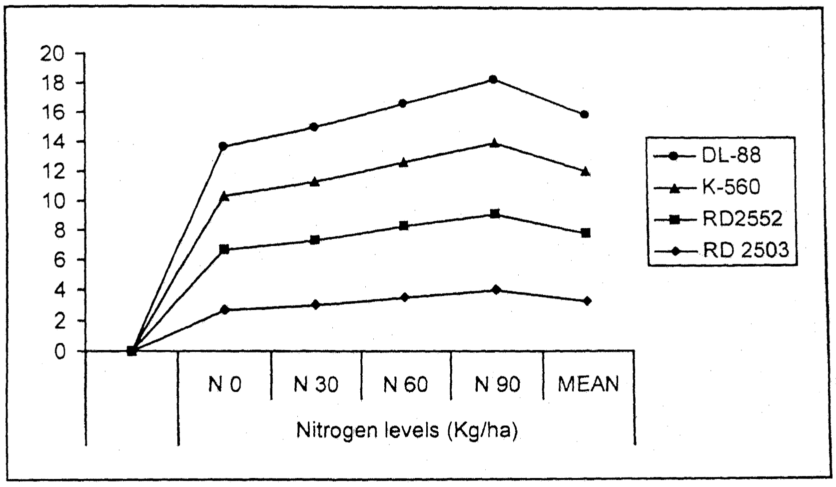
Nitrogen levels (Kg/ha)

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	3.75	4.08	4.50	5.00	**4.33**
27 NOV.	3.08	3.42	3.83	4.17	**3.62**
MEAN	**3.41**	**3.75**	**4.17**	**4.58**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.25	0.07	0.15	0.22	0.45	0.32	0.29
C.D. 5%	0.62	0.17	N.S.	0.45	N.S.	N.S.	N.S.

Graph-4.17 No. of tillers/plant at 30 days as influenced by various treatments and their inateraction (II year)





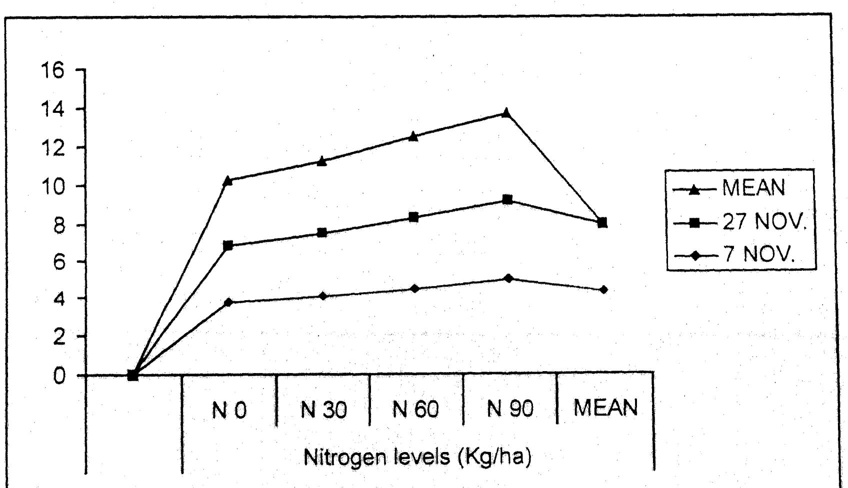


Table 4.18 **No. of tillers/plant at 60 days as influenced by various treatments and their interaction (Ist year)**

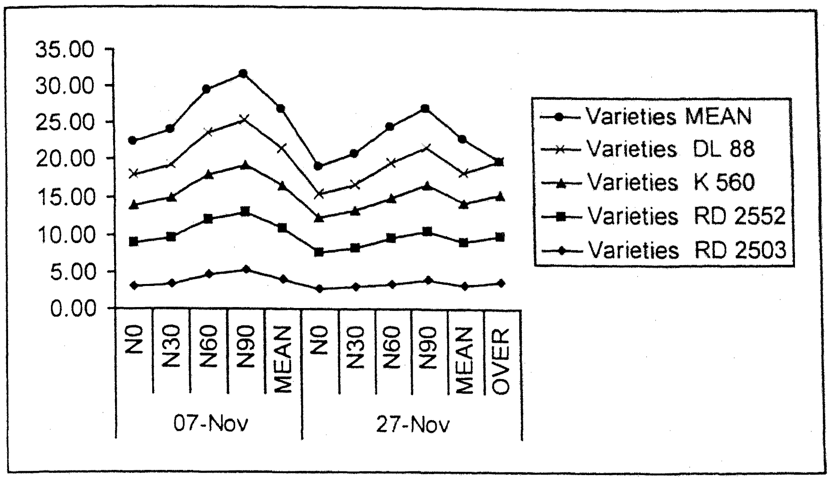
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	3.00	6.00	5.00	4.00	**4.50**
	N_{30}	3.33	6.33	5.33	4.33	**4.83**
	N_{60}	4.67	7.33	6.00	5.67	**5.92**
	N_{90}	5.33	7.67	6.33	6.00	**6.33**
	MEAN	**4.08**	**6.83**	**5.66**	**5.00**	**5.39**
27-Nov	N_0	2.67	5.00	4.67	3.00	**3.83**
	N_{30}	3.00	5.33	5.00	3.33	**4.16**
	N_{60}	3.33	6.33	5.33	4.67	**4.91**
	N_{90}	4.00	6.67	6.00	5.00	**5.42**
	MEAN	**3.25**	**5.83**	**5.25**	**4.00**	**4.58**
OVER ALL MEAN		**3.66**	**6.33**	**5.45**	**4.50**	

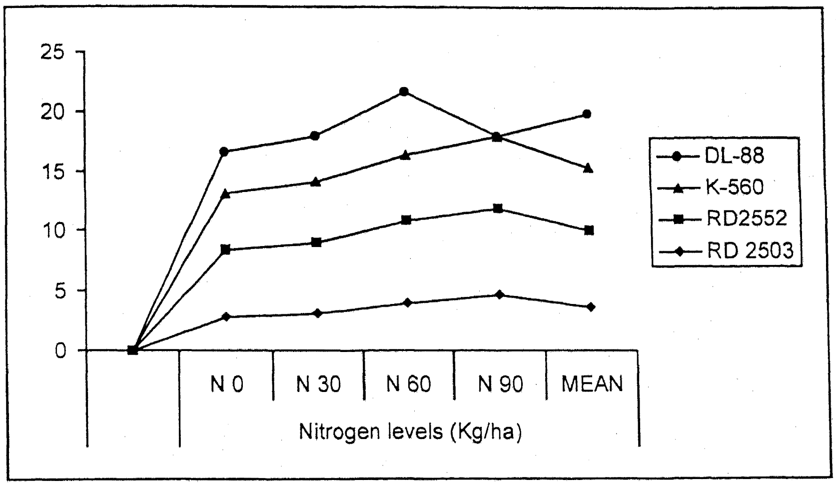
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	2.83	3.16	4.00	4.66	**3.66**
RD2552	5.50	5.83	6.83	7.17	**6.33**
K-560	4.83	5.16	5.66	6.16	**5.45**
DL-88	3.50	3.83	5.17	5..5	**4.50**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	4.50	4.83	5.92	6.33	**5.39**
27 NOV.	3.83	4.16	4.91	5.42	**4.58**
MEAN	**4.16**	**4.49**	**5.41**	**5.87**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.19	0.12	0.25	0.25	0.50	0.36	0.33
C.D. 5%	0.49	0.28	N.S.	0.51	N.S.	N.S.	N.S.

Graph-4.18 No. of tillers/plant at 60 days as influenced by various treatments and their inateraction (I year)





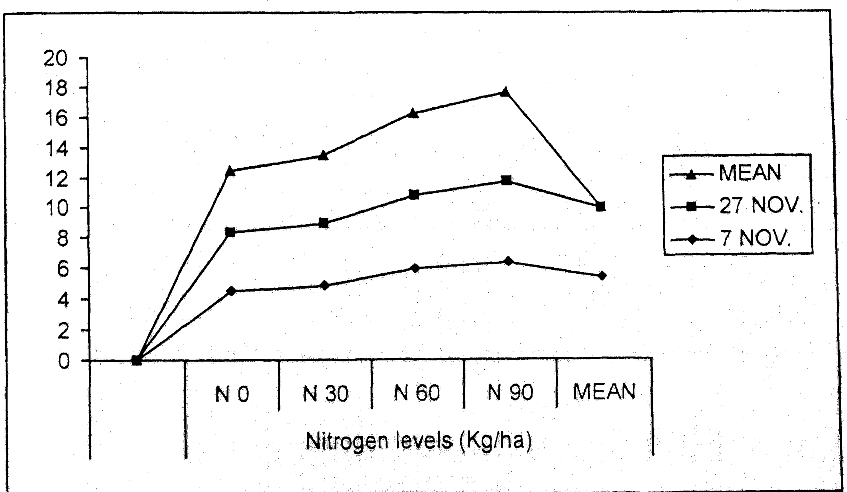


Table 4.19 No. of tillers/plant at 60 days as influenced by various treatments and their interaction (II year)

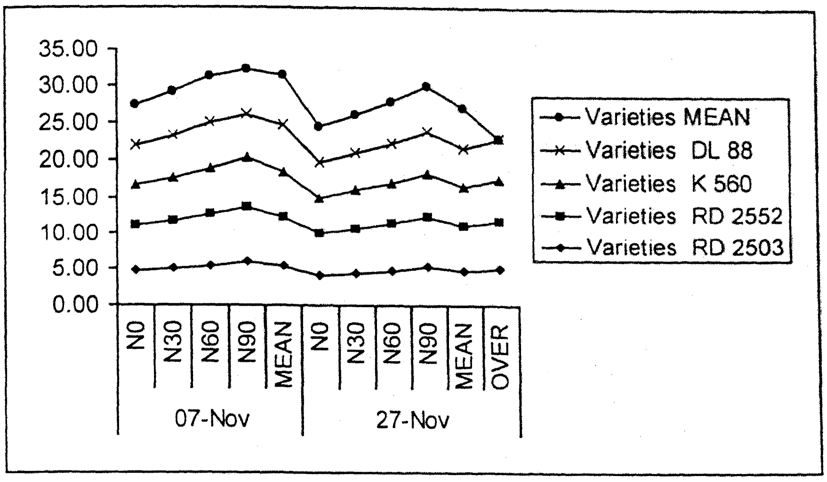
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	4.67	6.33	5.67	5.33	**5.50**
	N_{30}	5.00	6.67	6.00	5.67	**5.84**
	N_{60}	5.33	7.33	6.33	6.00	**6.25**
	N_{90}	6.00	7.67	6.67	5.83	**6.06**
	MEAN	**5.25**	**7.00**	**6.17**	**6.33**	**6.67**
27-Nov	N_0	4.00	6.00	5.00	4.67	**4.92**
	N_{30}	4.33	6.33	5.33	5.00	**5.25**
	N_{60}	4.67	6.67	5.67	5.33	**5.58**
	N_{90}	5.33	7.00	6.00	5.67	**6.00**
	MEAN	**4.58**	**6.50**	**5.50**	**5.17**	**5.44**
OVER ALL MEAN		**4.92**	**6.75**	**5.83**	**5.50**	

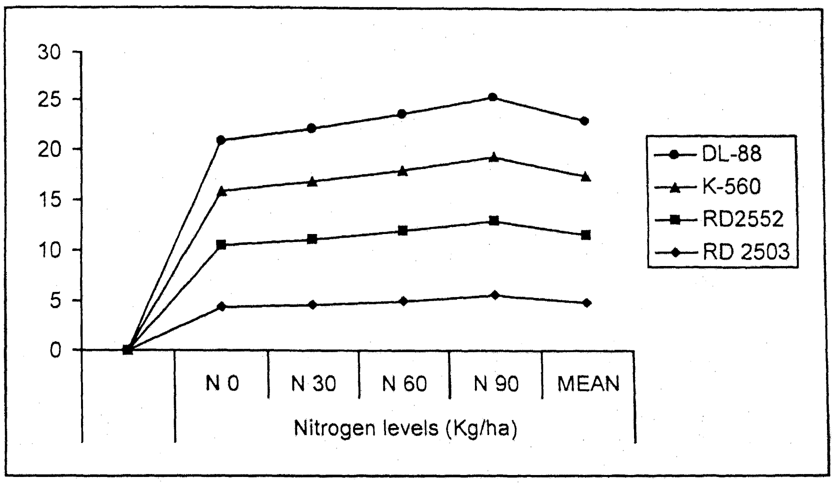
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	4.33	4.67	5.00	5.67	**4.92**
RD2552	6.17	6.50	7.00	7.33	**6.75**
K-560	5.33	5.67	6.00	6.34	**5.83**
DL-88	5.00	5.34	5.67	6.00	**5.50**

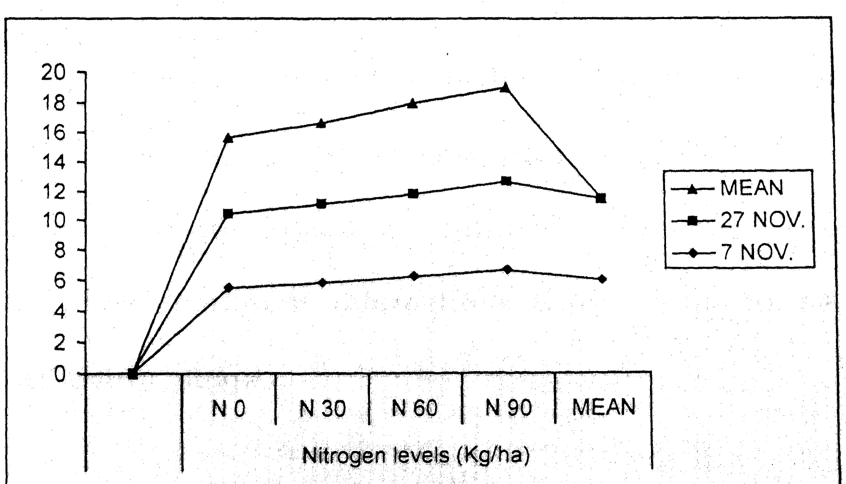
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	5.50	5.84	6.25	6.67	**6.06**
27 NOV.	4.92	5.25	5.58	6.00	**5.44**
MEAN	**5.21**	**5.54**	**6.13**	**6.33**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.14	0.12	0.25	0.22	0.44	0.31	0.30
C.D. 5%	0.34	0.29	N.S.	0.44	N.S.	N.S.	N.S.

Graph-4.19 **No. of tillers/plant at 60 days as influenced by various treatments and their inateraction (II year)**







2552 registered significantly higher tiller number (6.33/plants in first year and 6.75/plant in second year) over rest of the varieties. However, the second best was K-560. The lowest tiller number was recorded in case of RD 2503 (3.66 and 4.92/plant in the respective years.) Late sowing by 20 days significantly discouraged the tiller formation, whereas increasing N levels upto N_{90} encouraged this parameter. Thus at N_{90} the maximum tiller number was 5.87 / plant in first year and 6.33/plant in second year. The treatment interactions did not deviate this parameter significnatly at this stage also.

stages

4.1.11 No. of tillers as different growth ~~intervals~~:

Summary table 4.20 (a) and 4.20 (b) indicate that the tiller number /m row length was in general enhanced with the enhancement of plant growth only upto 60 days stage. Thereafter, it started declining slightly as revealed at 90 days stage. The number of tillers per metre row lenght as well as per plant was found highest in variety RD 2552 at every stage of plant growth. This was followed by K-560 and DL-88. The lowest tiller number was obtained in variety RD 2503 at every stage. Late sowing by 20 days discouraged the formation of tillers significantly, whereas increasing levels of nitrogen upto N_{90} encouraaged it significantly at every stage of plant growth. The treatment interactions were found to be non-significant at every stage.

Summary table 4.20 (a)

Plant population/m row length and no. of tillers/m row length at different growth ~~intervals~~ stages

Treatments	Plant population/m row length			No of tillers/m row length					
Main plot treatments	30 Days			60 Days			90 Days		
Varieties	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean
V_1-(R.D.2503)	21.71	25.87	**23.79**	80.37	128.37	**104.37**	78.54	126.58	**102.56**
V_2-(R.D.2552)	23.25	27.97	**25.61**	145.87	189.29	**167.58**	144.12	187.71	**165.91**
V_3-(K.560)	24.96	28.92	**26.94**	137.21	169.29	**153.25**	135.50	167.92	**151.71**
V_4-(DL.88)	22.39	27.04	**24.72**	100.41	149.58	**124.99**	98.83	148.00	**123.41**
C.D.(5%)	00.94	00.22	**00.58**	09.13	11.13	**10.13**	09.75	09.46	**09.61**
Sub plot treatments									
Date of sowing									
D_1-(7th November)	24.33	29.08	**26.70**	132.14	177.08	**154.61**	130.48	175.36	**152.92**
D_2-(27th November)	21.77	25.81	**23.79**	99.81	171.19	**135.50**	98.02	139.75	**118.88**
C.D.(5%)	00.66	00.16	**00.41**	08.05	06.32	**07.18**	08.07	04.47	**06.27**
Sub sub plot treatments									
Nitrogen levels (Kg/ha.)									
N_1-(Control)	22.00	26.62	**24.31**	90.46	139.87	**115.16**	88.83	138.33	**113.58**
N_2-(30 Kg/ha.)	22.74	27.20	**24.97**	103.58	151.57	**127.66**	102.25	150.00	**126.12**
N_3-(60 Kg/ha.)	23.41	27.67	**25.54**	127.83	164.67	**146.25**	125.83	163.17	**144.50**
N_4-(90 Kg/ha.)	24.04	28.30	**26.17**	142.00	180.25	**161.12**	140.08	178.71	**159.39**
C.D.(5%)	00.85	00.46	**00.66**	12.70	08.66	**10.68**	12.66	08.51	**10.58**
Interaction									
VxD	N.S.	00.32		N.S.	N.S.			N.S.	**N.S.**
VxN	N.S.	N.S.		N.S.	N.S.			N.S.	**N.S.**
DxN	N.S.	N.S.		N.S.	N.S.			N.S.	**N.S.**
VxDxN	N.S.	N.S.		N.S.	N.S.			N.S.	**N.S.**

Summary table -4.20(b)

No of tillers/plant at different growth intervals

Treatments	**No of tillers / plant**					
Main plot treatments	**30 Days**			**60 Days**		
Varieties	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**
V_1-(R.D.2503)	02.87	03.29	**03.08**	03.66	04.92	**04.29**
V_2-(R.D.2552)	04.29	04.58	**04.43**	06.33	06.75	**06.54**
V_3-(K.560)	03.91	04.21	**04.06**	05.45	05.83	**05.64**
V_4-(DL.88)	03.58	03.83	**03.70**	04.50	05.50	**05.00**
C.D.(5%)	00.45	00.62	**00.53**	00.49	00.34	**00.41**
Sub plot treatments						
Date of sowing						
D_1-(7th November)	04.08	04.33	**04.20**	05.39	06.06	**05.72**
D_2-(27th November)	03.25	03.62	**03.43**	04.58	05.44	**05.01**
C.D.(5%)	00.23	00.17	**00.12**	00.28	00.29	**00.28**
Sub sub plot treatments						
Nitrogen levels (Kg/ha.)						
N_1-(Control)	03.00	03.41	**03.20**	04.16	05.21	**04.68**
N_2-(30 Kg/ha.)	03.41	03.75	**03.58**	04.49	05.54	**05.01**
N_3-(60 Kg/ha.)	03.91	04.17	**04.04**	05.41	06.13	**05.77**
N_4-(90 Kg/ha.)	04.33	04.58	**04.45**	05.87	06.33	**06.10**
C.D.(5%)	00.41	00.45	**00.43**	00.51	00.44	**00.47**
Interaction						
VxD	N.S.	N.S.		N.S.	N.S.	
VxN	N.S.	N.S.		N.S.	N.S.	
DxN	N.S.	N.S.		N.S.	N.S.	
VxDxN	N.S.	N.S.		N.S.	N.S.	

Bold

4.1.12 No. of functional leaves/plant at 30 DAS:

Varieties, sowing dates and N levels brought about significant changes in the number of leaves/plant at 30 days stage of crop growth. However, the treatment interactions did not exert any significant influence in both the years. (Table 4.21 and 4.22) RD 2552 and DL 88 resulted in equally higher leaves number / plant being significant over RD 2503 and K 560 (11.63 to 12.00 / plnat in first year and 14.50 to 15.00 / plnat in second year). K-560 recorded the lowest leaves number (10.37 and 13.25/plant in the respective years). Late sowing by 20 days resulted in significant reduction in this parameter over normal sowing date. Increasing levels of nitrogen encouraged the leave number. Accordingly, the maximum values were 12.50 leaves/plant in first year and 15.12 leaves/plant in the second year). These were significantly superior to No and N_{30} levels of nitrogen.

4.1.13 No. of funtional leaves/plant at 60 DAS:

The data in table 4.23 and 4.24 indicate the similar result trend of results at this growth stage also. RD 2552 and DL88 resulted in equally higher leaves number/plant being significant over RD 2503 and K560 (25.12 to 25.62 /plant in first year and 30.12 to 31.50 /plant in second year). K-560 recorded the minimum leaves number (22.87 and 26.75/plant in the respective years). Late sowing by 20 days resulted in reduction in leaves number from 26.06 to

Table 4.21 No. of functional leaves/plant 30 days as influenced by various treatments and their interaction (I year)

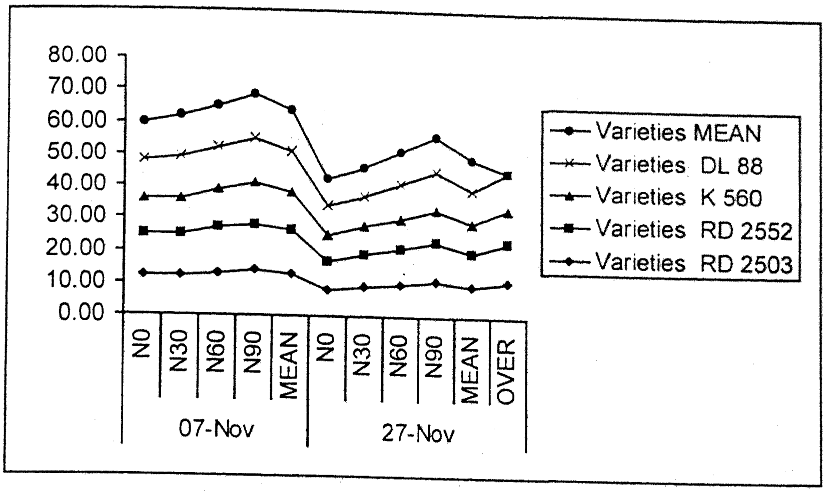
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	12.00	13.00	11.00	12.00	**12.00**
	N_{30}	12.00	13.00	11.00	13.00	**12.95**
	N_{60}	13.00	14.00	12.00	13.00	**13.00**
	N_{90}	14.00	14.00	13.00	14.00	**13.75**
	MEAN	**12.75**	**13.50**	**11.75**	**13.00**	**12.75**
27-Nov	N_0	8.00	9.00	8.00	9.00	**8.50**
	N_{30}	9.00	10.00	9.00	9.00	**9.25**
	N_{60}	10.00	11.00	9.00	11.00	**10.25**
	N_{90}	11.00	12.00	10.00	12.00	**11.25**
	MEAN	**9.50**	**10.50**	**9.00**	**10.25**	**9.81**
	OVER ALL MEAN	**11.13**	**12.00**	**10.37**	**11.63**	

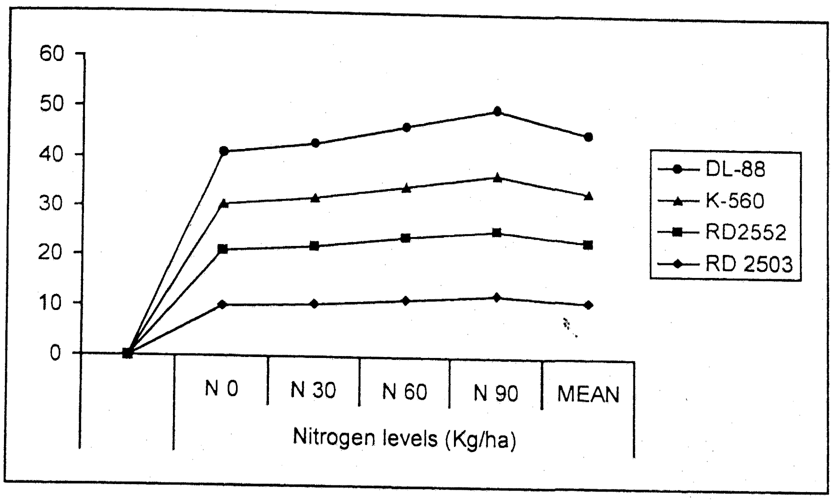
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	10.00	10.50	11.50	12.50	**11.13**
RD2552	11.00	11.50	12.50	13.00	**12.00**
K-560	9.50	10.00	10.50	11.50	**10.37**
DL-88	10.50	11.00	12.00	13.00	**11.63**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	12.00	12.25	13.00	13.75	**12.75**
27 NOV.	8.50	9.25	10.25	11.25	**9.81**
MEAN	**10.25**	**10.75**	**11.62**	**12.50**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.33	0.46	0.91	0.49	0.98	0.69	0.75
C.D. 5%	0.81	1.05	N.S.	98.00	N.S.	N.S.	N.S.

Graph-4.21 No. of functional leaves/plant 30 days as influenced by various treatments and their inateraction (I year)





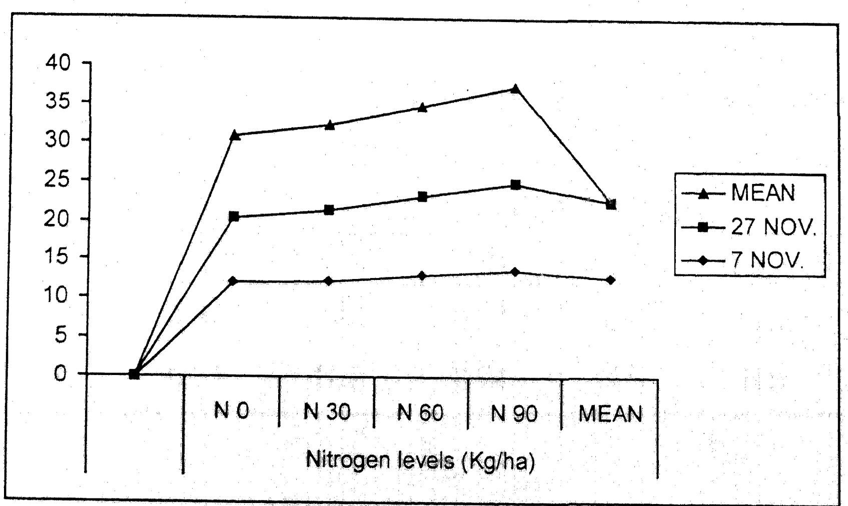


Table 4.22 No. of functional leaves/plant at 30 days as influenced by various treatments and their interaction (II year)

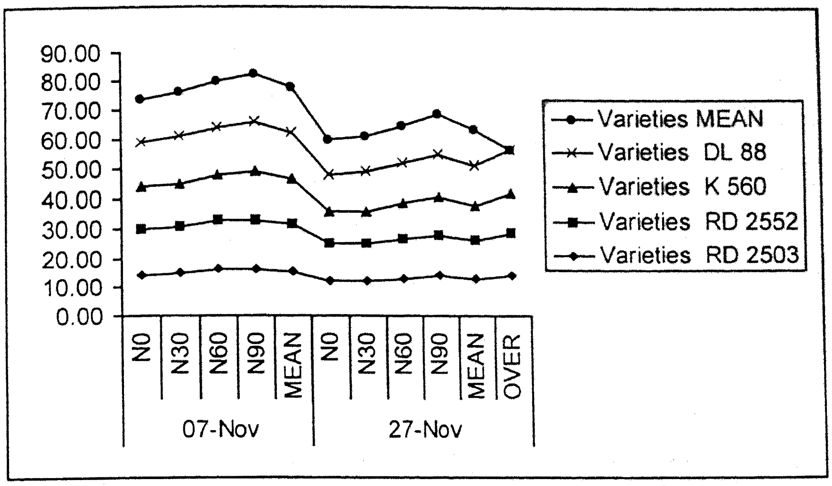
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	14.00	16.00	14.00	15.00	**14.75**
	N_{30}	15.00	16.00	14.00	16.00	**15.25**
	N_{60}	16.00	17.00	15.00	16.00	**16.00**
	N_{90}	16.00	17.00	16.00	17.00	**16.50**
	MEAN	**15.25**	**16.50**	**14.75**	**16.00**	**15.62**
27-Nov	N_0	12.00	13.00	11.00	12.00	**12.00**
	N_{30}	12.00	13.00	11.00	13.00	**12.25**
	N_{60}	13.00	14.00	12.00	13.00	**13.00**
	N_{90}	14.00	14.00	13.00	14.00	**13.75**
	MEAN	**12.75**	**13.50**	**11.75**	**13.00**	**12.75**
OVER ALL MEAN		**14.00**	**15.00**	**13.25**	**14.50**	

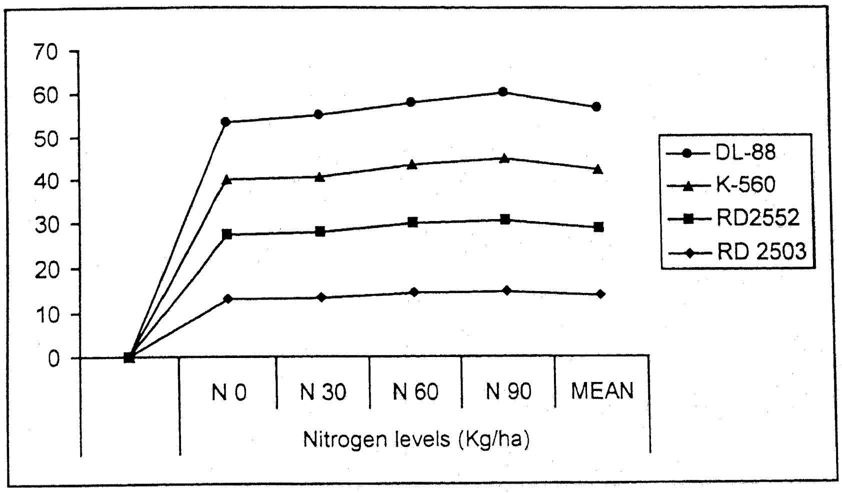
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	13.00	13.50	14.50	15.00	**14.00**
RD2552	14.50	14.50	15.50	15.50	**15.00**
K-560	12.50	12.50	13.50	14.50	**13.25**
DL-88	13.50	14.50	14.50	15.50	**14.50**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	14.75	15.25	16.00	16.50	**15.62**
27 NOV.	12.00	12.25	13.00	13.75	**12.75**
MEAN	**13.37**	**13.75**	**14.50**	**15.12**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.33	0.32	0.64	0.37	0.74	0.62	0.56
C.D. 5%	0.81	0.74	N.S.	0.74	N.S.	N.S.	N.S.

Graph-4.22 **No. of functional leaves/plant 30 days as influenced by various treatments and their inateraction (II year)**





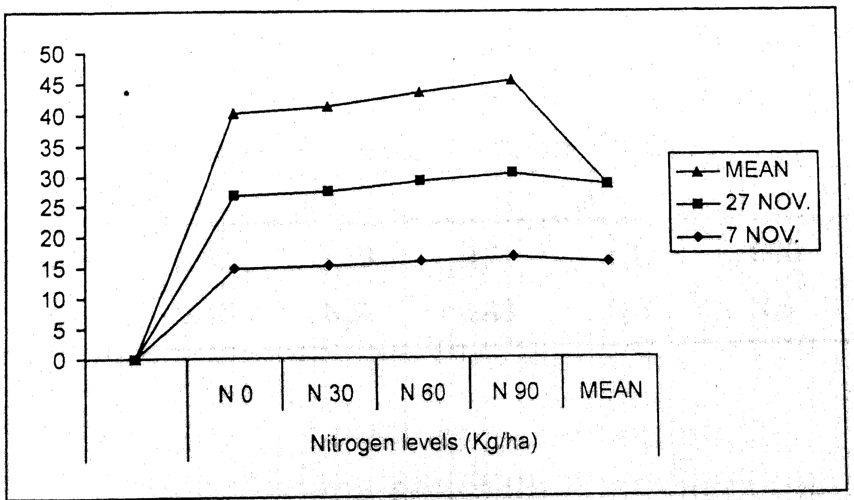


Table 4.23 No. of functional leaves/plant at 60 days as influenced by various treatments and their interaction (Ist year)

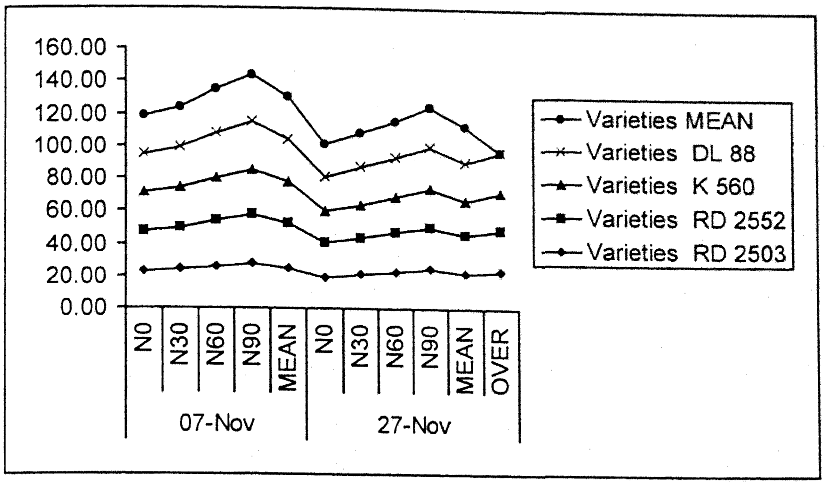
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	23.00	25.00	23.00	24.00	**23.75**
	N_{30}	24.00	26.00	24.00	25.00	**24.75**
	N_{60}	26.00	28.00	26.00	28.00	**27.00**
	N_{90}	28.00	30.00	27.00	30.00	**28.75**
	MEAN	**25.25**	**27.25**	**25.00**	**26.75**	**26.06**
27-Nov	N_0	19.00	22.00	19.00	21.00	**20.25**
	N_{30}	21.00	23.00	20.00	23.00	**21.75**
	N_{60}	23.00	25.00	21.00	24.00	**23.25**
	N_{90}	25.00	26.00	23.00	26.00	**25.00**
	MEAN	**22.00**	**24.00**	**20.75**	**23.50**	**22.56**
OVER ALL MEAN		**23.62**	**25.62**	**22.87**	**25.12**	

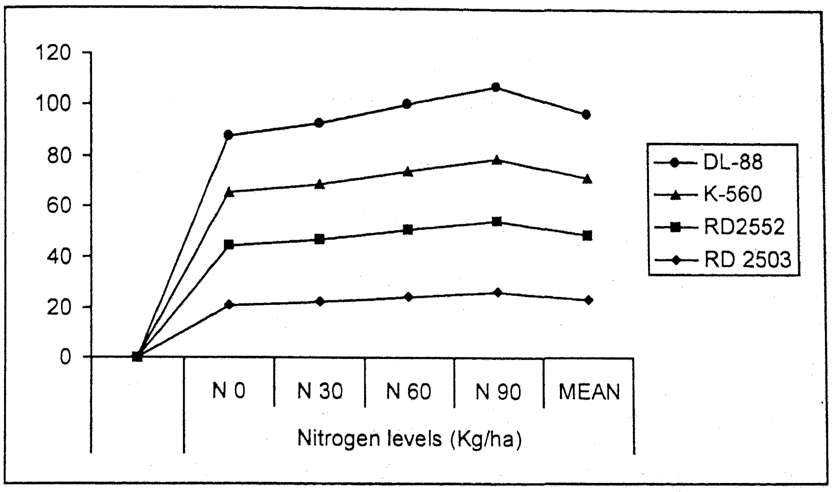
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	21.00	22.50	24.50	26.50	**23.62**
RD2552	23.50	24.50	26.50	28.00	**25.62**
K-560	21.00	22.00	23.50	25.00	**22.87**
DL-88	22.50	24.00	26.00	28.00	**25.12**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	23.75	24.75	27.00	28.75	**26.06**
27 NOV.	20.25	21.75	23.25	25.00	**22.56**
MEAN	**22.00**	**23.25**	**25.12**	**26.87**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.67	0.60	1.19	0.71	1.42	1.00	1.05
C.D. 5%	1.64	1.38	N.S.	1.43	N.S.	N.S.	N.S.

Graph-4.23 **No. of functional leaves/plant 60 days as influenced by various treatments and their inateraction (I year)**





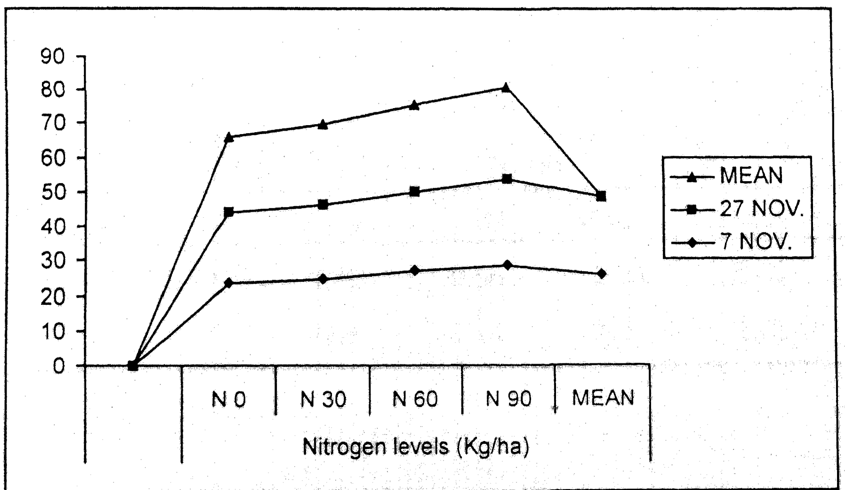


Table 4.24 No. of functional leaves/plant at 60 days as influenced by various treatments and their interaction (II year)

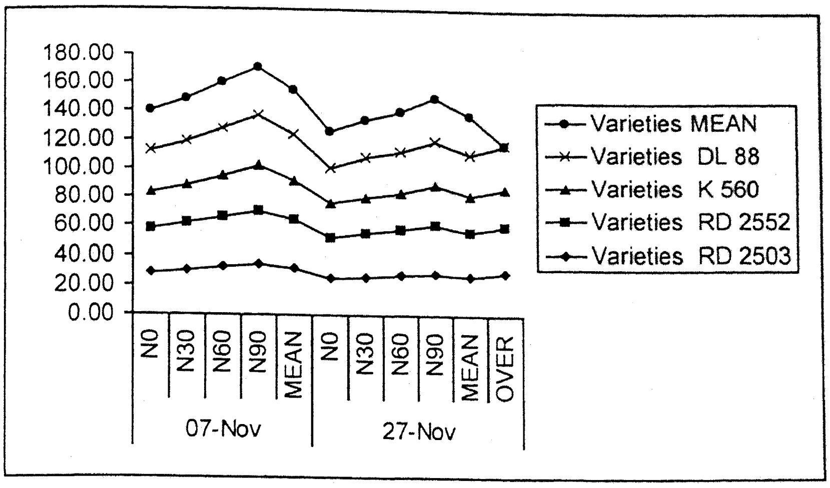
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	28.00	30.00	25.00	29.00	**28.00**
	N_{30}	30.00	32.00	26.00	31.00	**29.75**
	N_{60}	32.00	34.00	29.00	33.00	**32.00**
	N_{90}	34.00	36.00	32.00	35.00	**34.25**
	MEAN	**31.00**	**33.00**	**28.00**	**32.00**	**31.00**
27-Nov	N_0	25.00	27.00	24.00	25.00	**25.25**
	N_{30}	26.00	29.00	25.00	28.00	**27.00**
	N_{60}	27.00	31.00	25.00	29.00	**28.00**
	N_{90}	28.00	33.00	28.00	31.00	**30.00**
	MEAN	**26.50**	**30.00**	**25.50**	**28.25**	**27.56**
	OVER ALL MEAN	**28.75**	**31.50**	**26.75**	**30.12**	

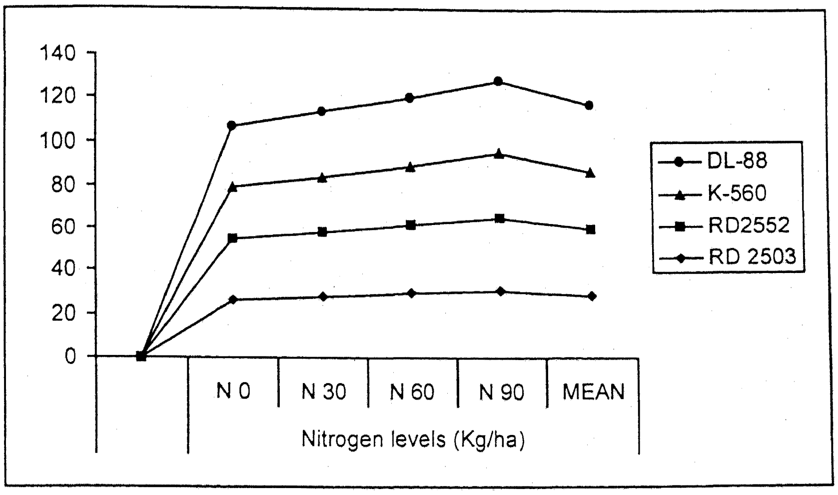
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	26.50	28.00	29.50	31.00	**28.75**
RD2552	28.50	30.50	32.50	34.50	**31.50**
K-560	24.50	25.50	27.00	30.00	**26.75**
DL-88	27.00	29.50	31.00	33.00	**30.12**

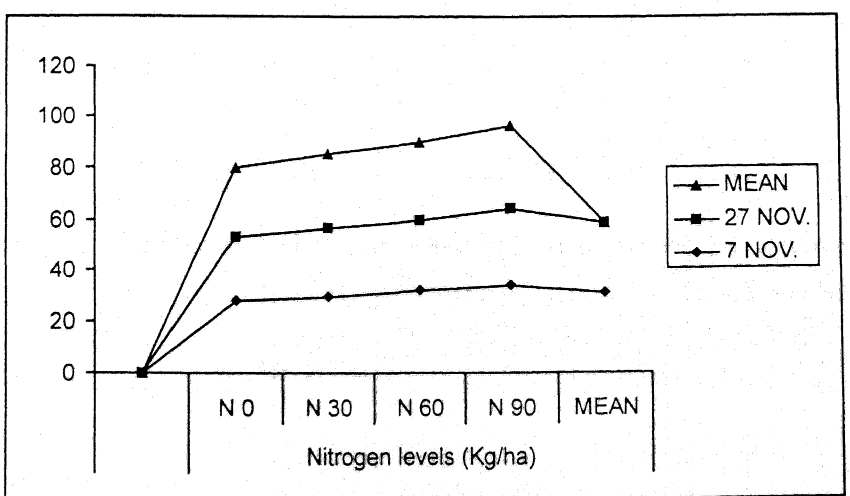
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	28.00	29.75	32.00	34.25	**31.00**
27 NOV.	25.25	27.00	28.00	30.00	**27.56**
MEAN	**26.62**	**28.37**	**30.00**	**32.12**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.69	0.51	1.02	0.56	1.13	0.80	0.86
C.D. 5%	1.68	1.18	N.S.	1.14	N.S.	1.61	N.S.

Graph-4.24 **No. of functional leaves/plant 60 days as influenced by various treatments and their inateraction (II year)**







22.56/plant in first year, and 31.00 to 27.56/plant in the second year. Increasing levels of nitrogen increased the functional leaves significantly. As such, at highest N level (N_{90}), the leaves number was maximum (26.87 and 32.12)/plant in the respective years). However, the lowest leaves number was found to be 22.00/plant in first year and 26.02/plant in the second year.

4.1.14 No. of functional leaves/plant at 90 DAS:

Similar result trend was observed at this stage also as revealed from Table 4.25 and 4.26. The treatment interactions were found to be non-significant during both the years. RD 2552 and DL 88 recorded equally higher number of leaves, being significantly superior to RD 2503 and K560 varieites (23.12 to 23.75/plant in first year and 28.37 to 29.75/plant in second year). K560 registered the lowest leaf number (20.12 in first year and 25.00/plant in second year). Late sowing by 20 days significantly discouraged the formation of funtional leaves, whereas increasing N levels encouraged this parameter significantly. As such, the maximum leaf number (23.87 in first year and 29.37/plant in second year) was noted in case of highest N level i.e. N_{90} . On the other hand the minimum leaves (20.37 and 25.25/plant in respective years) were recorded in case of no nitrogen (control).

Table 4.25 No. of functional leaves/plant at 90 days as influenced by various treatments and their interaction (I year)

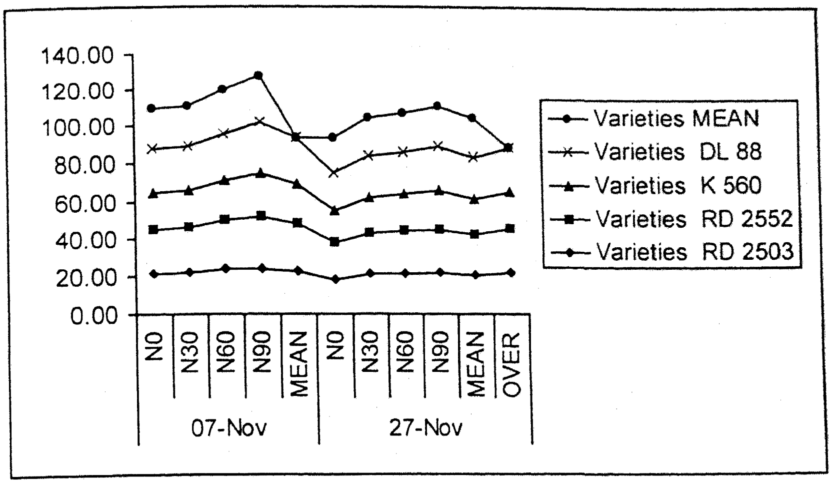
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	21.00	24.00	20.00	23.00	**22.00**
	N_{30}	22.00	24.00	20.00	23.00	**22.25**
	N_{60}	24.00	26.00	21.00	25.00	**24.00**
	N_{90}	24.00	28.00	23.00	27.00	**25.50**
	MEAN	**22.75**	**25.50**	**21.00**	**24.50**	**23..44**
27-Nov	N_0	18.00	20.00	17.00	20.00	**18.75**
	N_{30}	21.00	22.00	19.00	22.00	**21.00**
	N_{60}	21.00	23.00	20.00	22.00	**21.50**
	N_{90}	22.00	23.00	21.00	23.00	**22.25**
	MEAN	20.50	22.00	19.25	21.75	20.87
OVER ALL MEAN		**21.62**	**23.75**	**20.12**	**23.12**	

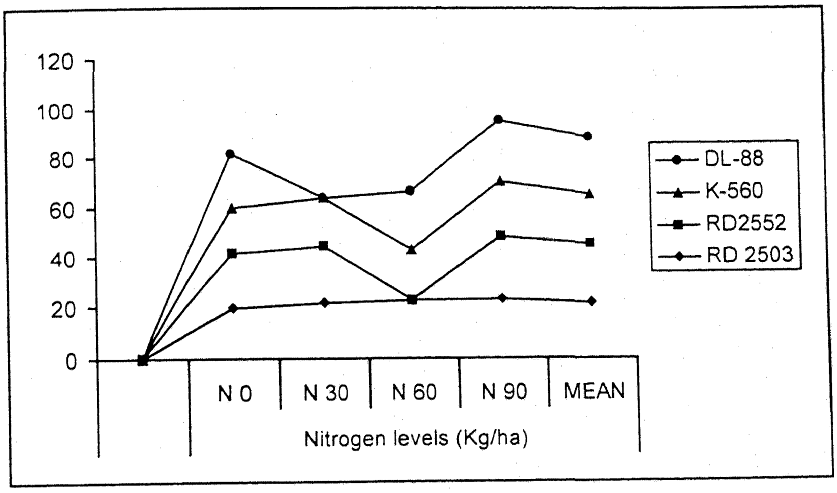
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	19.50	21.50	22.50	23.00	**21.62**
RD2552	22.00	23.00	24..5	25.50	**23.75**
K-560	18.50	19.50	20.50	22.00	**20.12**
DL-88	21.50	22..5	23.50	25.00	**23.12**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	22.00	22.25	24.00	25.50	**23.44**
27 NOV.	18.75	21.00	21.50	22.25	**20.87**
MEAN	**20.37**	**21.62**	**22.75**	**23.87**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.73	0.45	0.90	0.66	1.31	0.93	0.92
C.D. 5%	1.78	1.03	N.S.	1.32	N.S.	N.S.	N.S.

Graph-4.25 **No. of functional leaves/plant 90 days as influenced by various treatments and their inateraction (I year)**





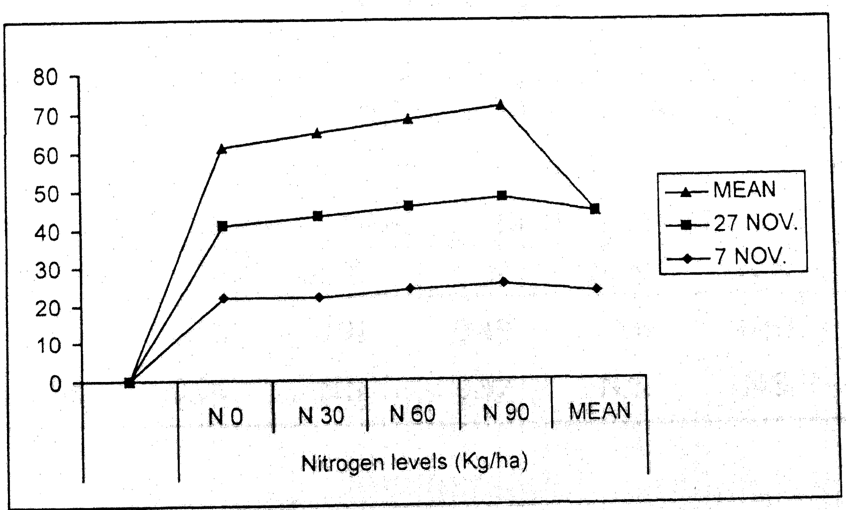


Table 4.26 No. of functional leaves/plant at 90 days as influenced by various treatments and their interaction (II year)

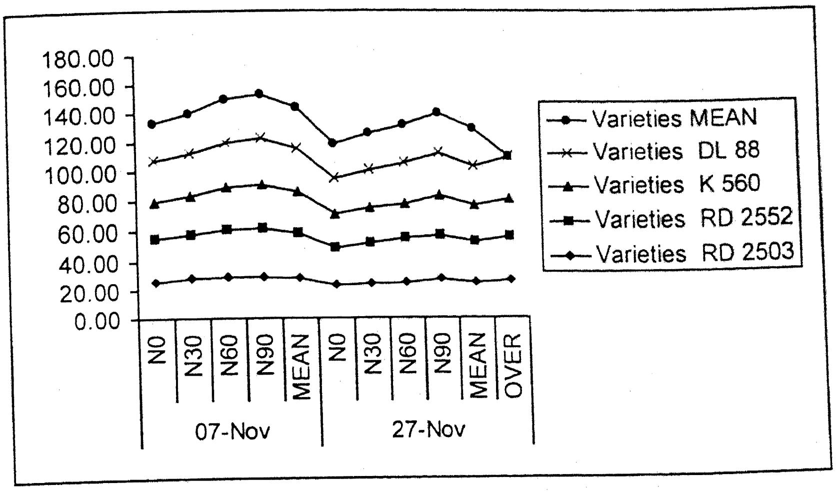
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	26.00	29.00	24.00	28.00	**26.75**
	N_{30}	28.00	30.00	25.00	29.00	**28.00**
	N_{60}	29.00	32.00	28.00	31.00	**30.00**
	N_{90}	29.00	33.00	29.00	32.00	**30.75**
	MEAN	**28.00**	**31.00**	**26.50**	**30.00**	**28.87**
27-Nov	N_0	23.00	26.00	22.00	24.00	**23.75**
	N_{30}	24.00	28.00	23.00	26.00	**25.25**
	N_{60}	25.00	30.00	23.00	28.00	**26.50**
	N_{90}	27.00	30.00	26.00	29.00	**28.00**
	MEAN	**24.75**	**28.50**	**23.50**	**26.75**	**25.87**
OVER ALL MEAN		**26.37**	**29.75**	**25.00**	**28.37**	

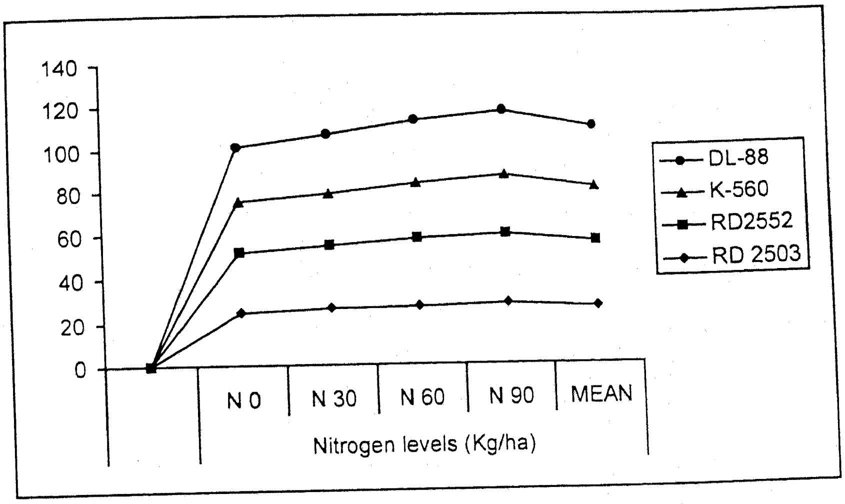
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	24.50	26.00	27.00	28.00	**26.37**
RD2552	27.50	29.00	31.00	31.50	**29.75**
K-560	23.00	24.00	25.50	27.50	**25.00**
DL-88	26.00	27.50	29.50	30.50	**28.37**

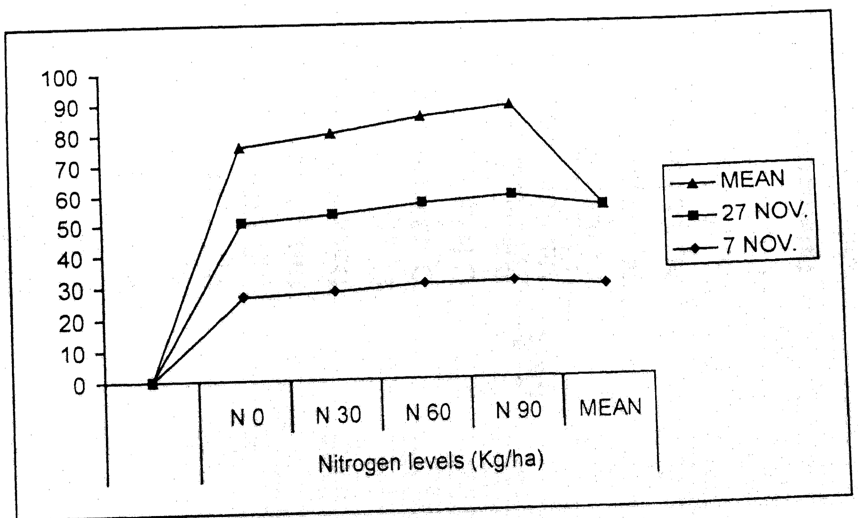
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	26.75	28.00	30.00	30.75	**28.87**
27 NOV.	23.75	25.25	26.50	28.00	**25.87**
MEAN	**25.25**	**26.62**	**28.25**	**29.37**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.64	0.41	0.92	0.48	0.96	0.68	0.72
C.D. 5%	1.58	0.94	N.S.	0.97	N.S.	N.S.	N.S.

Graph-4.26 **No. of functional leaves/plant 90 days as influenced by various treatments and their inateraction (II year)**







Summary table -4.27

No of functional leaves/plant at different growth ~~intervals~~ stages

Treatments	No of Functional Leaves /Plant								
	30 Days			60 Days			90 Days		
	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean
Main plot treatments									
Varieties									
V_1-(R.D.2503)	11.13	14.00	**12.56**	23.62	28.75	**26.18**	21.62	26.37	**23.99**
V_2-(R.D.2552)	12.00	15.00	**13.50**	25.62	31.50	**28.56**	23.75	29.75	**26.75**
V_3-(K.560)	10.37	13.25	**11.81**	22.87	26.75	**24.81**	20.12	25.00	**22.56**
V_4-(DL.88)	11.63	14.50	**13.06**	25.12	30.12	**27.62**	23.12	28.37	**25.74**
C.D.(5%)	00.81	00.81	**00.81**	01.64	01.68	**01.66**	01.78	01.58	**01.68**
Sub plot treatments									
Date of sowing									
D_1-(7th November)	12.75	15.62	**14.18**	26.06	31.00	**28.53**	23.44	28.87	**26.15**
D_2-(27th November)	09.81	12.75	**11.28**	22.56	27.56	**25.06**	20.87	25.87	**23.37**
C.D.(5%)	01.05	00.74	**00.89**	01.38	01.18	**01.28**	01.03	00.94	**00.98**
Sub sub plot treatments									
BK Nitrogen levels (Kg/ha.)									
N_1-(Control)	10.25	13.37	**11.81**	22.00	26.62	**24.31**	20.37	25.25	**22.81**
N_2-(30 Kg/ha.)	10.75	13.75	**12.25**	23.25	28.37	**25.81**	21.62	26.62	**24.12**
N_3-(60 Kg/ha.)	11.62	14.50	**13.06**	25.12	30.00	**27.56**	22.75	28.25	**25.50**
N_4-(90 Kg/ha.)	12.50	15.12	**13.81**	26.87	32.12	**29.49**	23.87	29.37	**26.62**
C.D.(5%)	00.98	00.74	**00.86**	01.43	01.14	**01.28**	01.32	00.97	**01.14**
Interaction									
VxD	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
VxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
DxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
VxDxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	

4.1.15 No. of functional leaves at different growth ~~intervals~~ Stage :

The summary Table 4.27 reveals that the formation of functional leaves/plant were encouraged by more than two fold between 30 and 60 days stages which is considered the most active period of vegetative growth phase. Thereafter, the it was started declining slowly due to leaf senescence and leaf fall. The number of functional leaves/plant were maxim,um in RD 2552, follwed by DL 88 and the lowest being in case of K560 at every stage of growth. The formation of functinal leaves was discourages due to late sowing by 20 days (7 November), however, application of nitrogen upto N_{90} encouraged this parameter significantly. None of the treatment interactions deviated the number of functional leaves significantly at any of the growth stages.

4.1.16 Leaf area index (LAI) at 30 DAS :

The results in Table 4.28 and 4.29 indicate that among the varieties, R.D 2552 registered maximum LAI (0.87 and 1.13 in respective years) being significantly superior to the remaining varieties. This was, however, followed by DL- 88, RD 2503 and then K 560. Late sowing discouraged and increasing N levels encouraged this parameter significantly in both the years. Thus, the highest LAI was found in case of normal sowing date and highest N level (N_{90}), the corresponding values were 0.91-0.92

Table 4.28 Leaf area index at 30 days as influenced by various treatments and their interaction (I year)

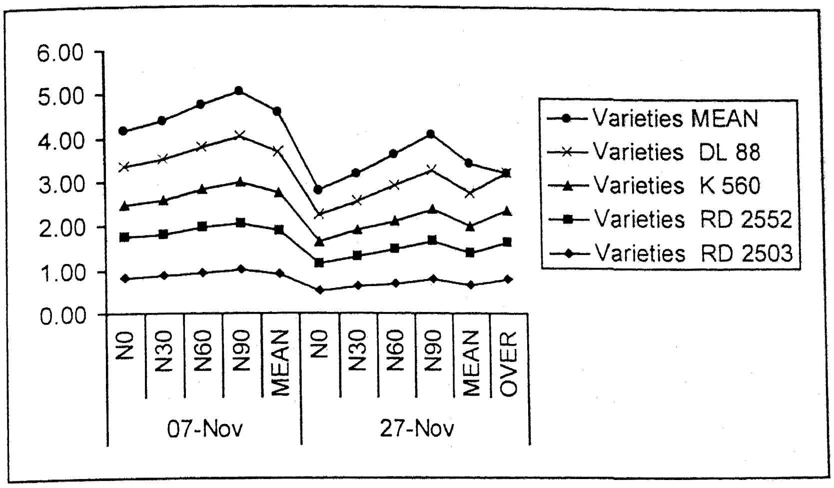
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	0.83	0.93	0.73	0.86	**0.84**
	N_{30}	0.87	0.95	0.77	0.94	**0.88**
	N_{60}	0.94	1.03	0.87	0.96	**0.95**
	N_{90}	1.02	1.05	0.94	1.04	**1.01**
	MEAN	**0.92**	**0.99**	**0.83**	**0.95**	**0.92**
27-Nov	N_0	0.53	0.62	0.50	0.60	**0.56**
	N_{30}	0.62	0.71	0.60	0.63	**0.64**
	N_{60}	0.70	0.80	0.62	0.79	**0.73**
	N_{90}	0.80	0.89	0.71	0.88	**0.82**
	MEAN	**0.66**	**0.75**	**0.61**	**0.72**	**0.69**
OVER ALL MEAN		**0.79**	**0.87**	**0.72**	**0.83**	

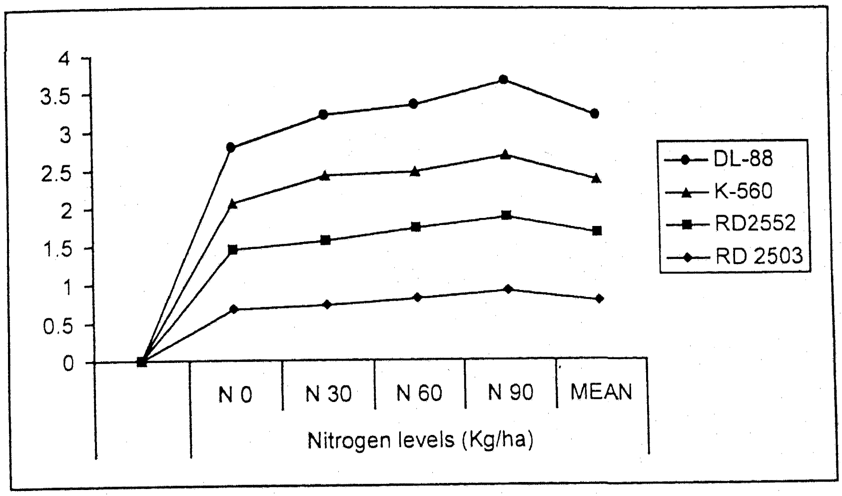
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	0.68	0.74	0.82	0.91	**0.79**
RD2552	0.77	0.83	0.91	0.97	**0.87**
K-560	0.62	0.86	0.75	0.82	**0.72**
DL-88	0.73	0.78	0.87	0.96	**0.83**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	0.84	0.88	0.95	1.01	**0.92**
27 NOV.	0.56	0.64	0.73	0.82	**0.69**
MEAN	**0.70**	**0.76**	**0.84**	**0.91**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.01	0.02	0.03	0.02	0.02
C.D. 5%	0.04	0.02	N.S.	0.03	N.S.	N.S.	N.S.

Graph-4.28 Leaf area index at 30 days as influenced by various treatments and their in ateraction (I year)





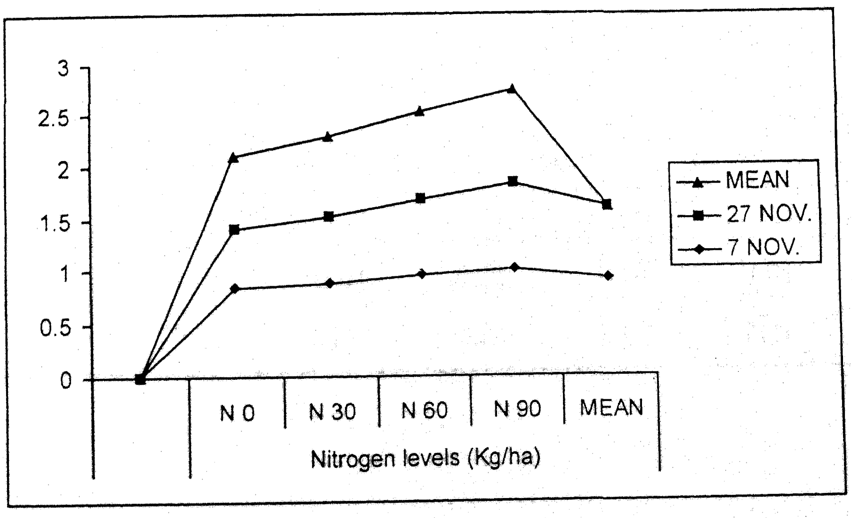


Table 4.29 Leaf area index at 30 days as influenced by various treatments and their interaction (II year)

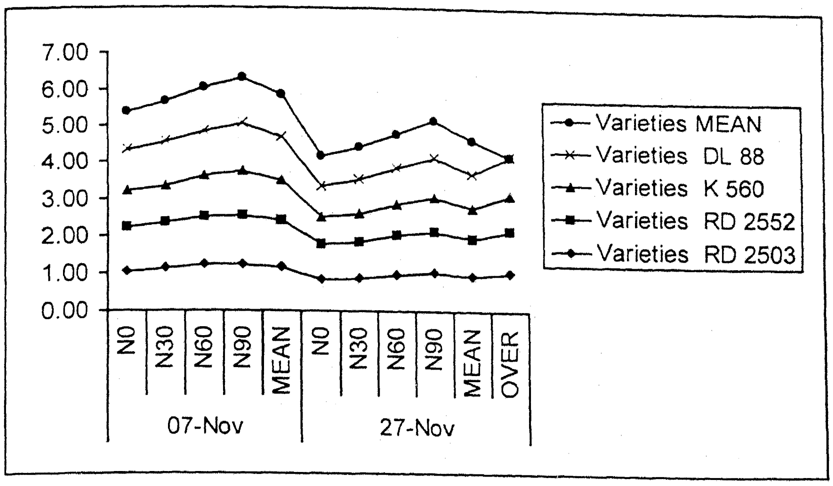
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	1.02	1.20	0.98	1.13	**1.08**
	N_{30}	1.12	1.21	1.02	1.20	**1.14**
	N_{60}	1.22	1.30	1.12	1.22	**1.21**
	N_{90}	1.23	1.32	1.20	1.31	**1.26**
	MEAN	**1.15**	**1.26**	**1.08**	**1.21**	**1.17**
27-Nov	N_0	0.83	0.94	0.72	0.84	**0.83**
	N_{30}	0.87	0.97	0.76	0.94	**0.88**
	N_{60}	0.97	1.05	0.85	0.97	**0.96**
	N_{90}	1.03	1.08	0.95	1.07	**1.03**
	MEAN	**0.92**	**1.01**	**0.82**	**0.95**	**0.92**
OVER ALL MEAN		**1.03**	**1.13**	**0.95**	**1.08**	

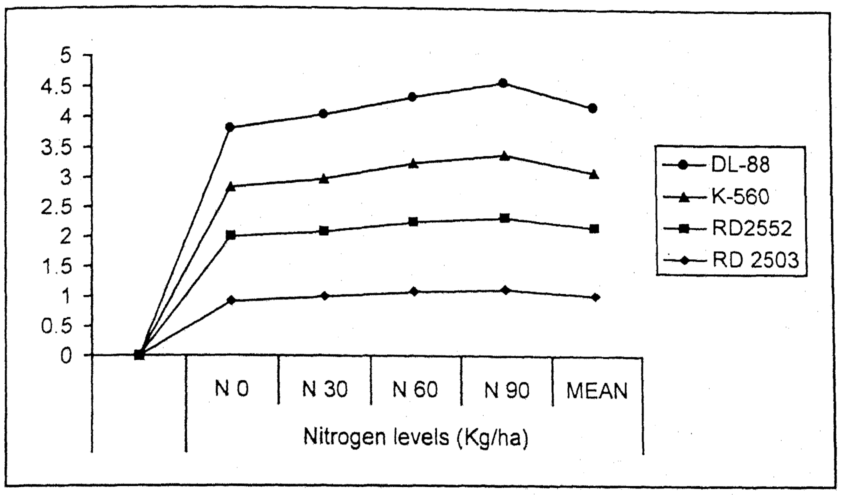
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	0.92	0.99	1.09	1.13	**1.03**
RD2552	1.07	1.09	1.17	1.20	**1.13**
K-560	0.85	0.89	0.98	1.07	**0.95**
DL-88	0.98	1.07	1.09	1.19	**1.08**

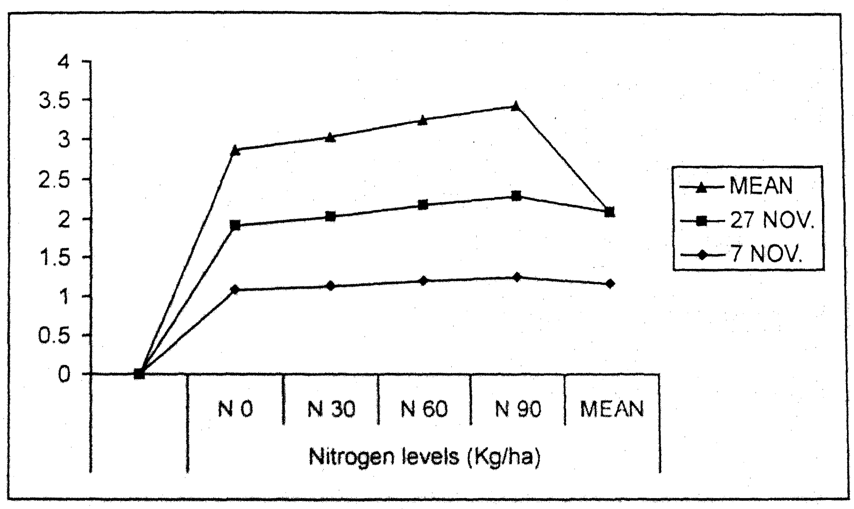
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	1.08	1.14	1.21	1.26	**1.17**
27 NOV.	0.83	0.88	0.96	1.03	**0.92**
MEAN	**0.95**	**1.01**	**1.08**	**1.14**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D. 5%	0.02	0.01	N.S.	0.01	0.03	N.S.	N.S.

Graph-4.29 **Leaf area index at 30 days as influenced by various treatments and their in ateraction (II year)**







LAI in first year and 1.14-1.17 LAI in the second year. On the other hand the lowest values were recorded to be 0.69 and 0.70 in first year and 0.92 and 0.95 in second year in case of late sowing and No level respectively. None of the treatment interactions were significant except in case of N x V in second year which was significant. Thus, the highest LAI was 1.19 and 1.20 in case of R.D 2552 with N_{90} and DL 88 with N_{90} respectively.

4.1.17 Leaf area index (LAI) at 60 DAS :

The similar ~~result~~ trend of results due to various treatment continued at this stage also in both the years (Table 4.30 and 4.31). RD 2552 recorded maximum LAI (2.19 and 2.82 in respective years). This was followed by DL 88 (2.13 and 2.67 in respective years). K-560 resulted in the lowest value (1.84 and 2.28 in respective years). Late sowing by 20 days decreased the LAI, while increasing N-levels increased the LAI significantly in both the years. Accordingly, the highest LAI was 2.28 in first year and 2.87 in second year due to N_{90}, while lowest LAI (1.81 and 2.29 respectively) was found in case of No . All the interactions were found siginificant only in the second year. Accordingly, RD 2552 when sown on normal date (7 November) with highest N level (N_{90}) recorded significantly highest 3.30 LAI over rest of the interactions. This was followed by DL 88 with the same treatment combinations (3.17 LAI). Thus, each variety responded the best with the normal sowing

Table 4.30 **Leaf area index at 60 days as influenced by various treatments and their interaction (I year)**

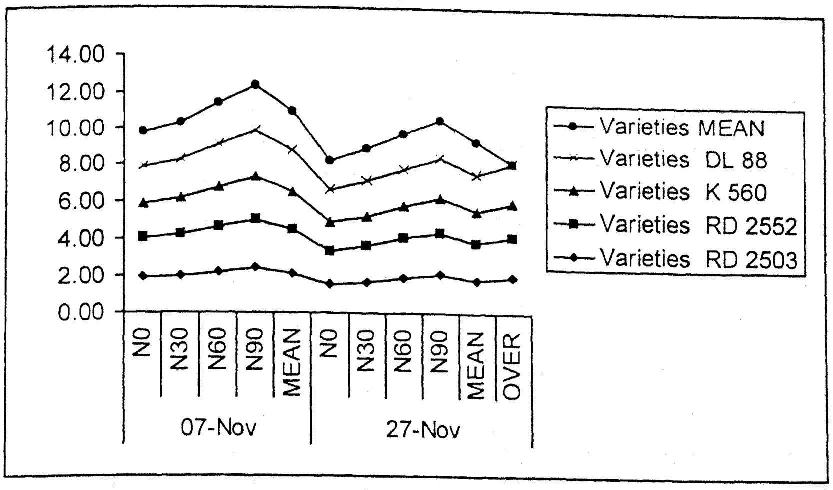
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	1.92	2.10	1.84	2.01	**1.97**
	N_{30}	2.01	2.23	1.92	2.14	**2.07**
	N_{60}	2.19	2.43	2.11	2.42	**2.29**
	N_{90}	2.42	2.61	2.27	2.60	**2.47**
	MEAN	**2.13**	**2.34**	**2.03**	**2.29**	**2.20**
27-Nov	N_0	1.53	1.84	1.48	1.75	**1.65**
	N_{30}	1.70	1.93	1.60	1.92	**1.79**
	N_{60}	1.92	2.16	1.69	2.02	**1.95**
	N_{90}	2.10	2.25	1.86	2.20	**2.10**
	MEAN	**1.81**	**2.05**	**1.66**	**1.97**	**1.87**
	OVER ALL MEAN	**1.97**	**2.19**	**1.84**	**2.13**	

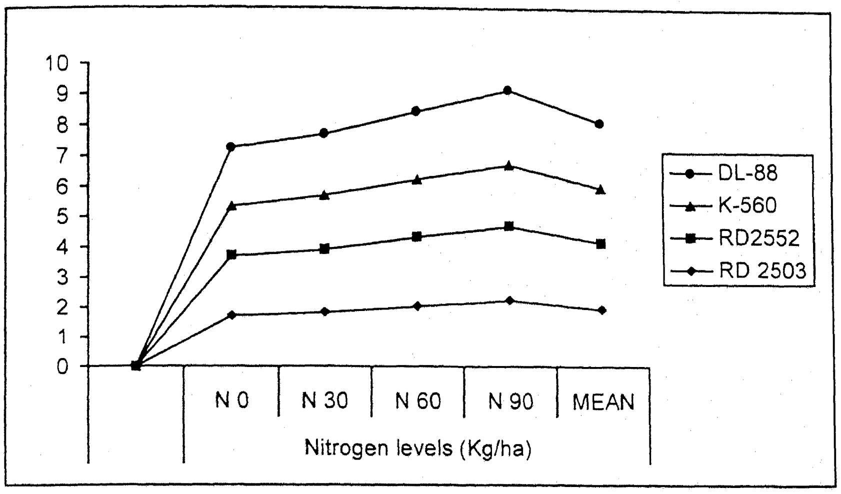
Varieties	**Nitrogen levels (Kg/ha)**				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	1.72	1.85	2.05	2.26	**1.97**
RD2552	1.97	2.08	2.29	2.43	**2.19**
K-560	1.66	1.76	1.90	2.06	**1.84**
DL-88	1.88	2.03	2.22	2.40	**2.13**

Date of sowing	**Nitrogen levels (Kg/ha)**				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	1.97	2.07	2.29	2.47	**2.20**
27 NOV.	1.65	1.79	1.95	2.10	**1.87**
MEAN	**1.81**	**1.93**	**2.12**	**2.28**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.03	0.02	0.04	0.02	0.05	0.03	0.03
C.D. 5%	0.07	0.05	N.S.	0.05	N.S.	N.S.	N.S.

Graph-4.30 Leaf area index at 60 days as influenced by various treatments and their in ateraction (I year)





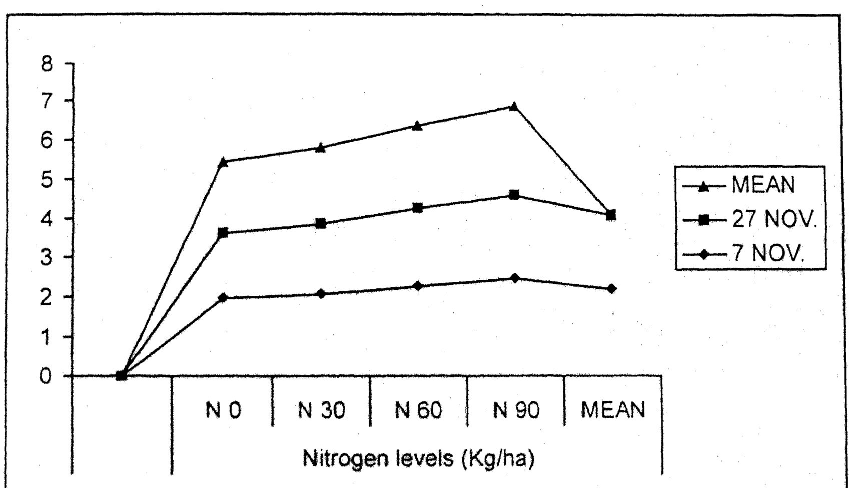


Table 4.31 Leaf area index at 60 days as influenced by various treatments and their interaction (II year)

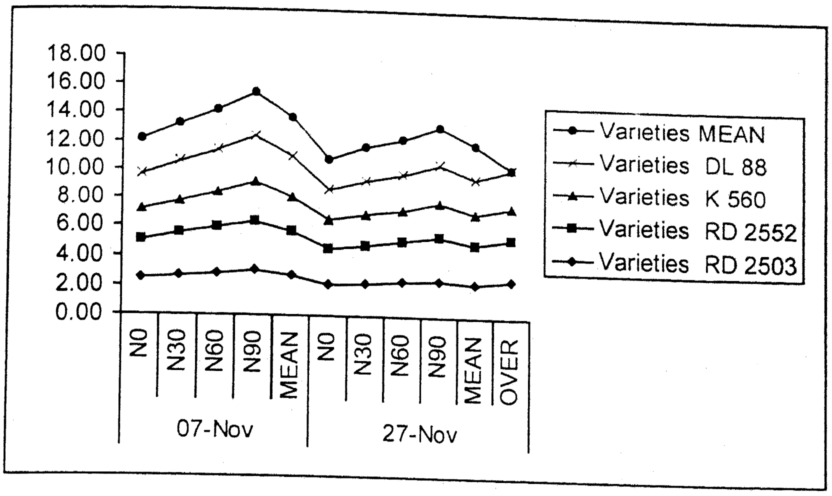
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	2.44	2.59	2.14	2.52	**2.42**
	N_{30}	2.65	2.90	2.20	2.79	**2.63**
	N_{60}	2.84	3.10	2.47	2.98	**2.85**
	N_{90}	3.06	3.30	2.83	3.17	**3.09**
	MEAN	**2.75**	**2.97**	**2.41**	**2.86**	**2.75**
27-Nov	N_0	2.12	2.39	1.98	2.19	**2.17**
	N_{30}	2.22	2.57	2.12	2.46	**2.34**
	N_{60}	2.37	2.79	2.13	2.57	**2.46**
	N_{90}	2.47	2.98	2.39	2.75	**2.65**
	MEAN	**2.29**	**2.68**	**2.15**	**2.49**	**2.40**
OVER ALL MEAN		**2.52**	**2.82**	**2.28**	**2.67**	

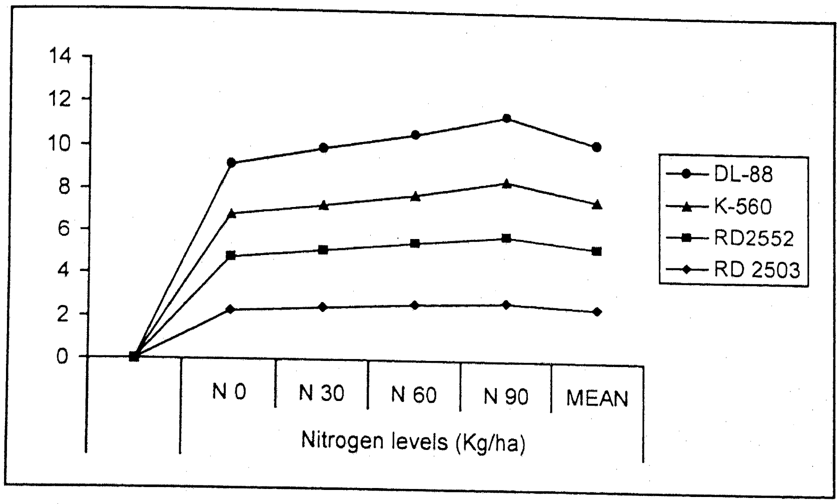
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	2.28	2.43	2.60	2.76	**2.52**
RD2552	2.49	2.73	2.94	3.14	**2.82**
K-560	2.06	2.16	2.30	2.61	**2.28**
DL-88	2.35	2.62	2.77	2.96	**2.67**

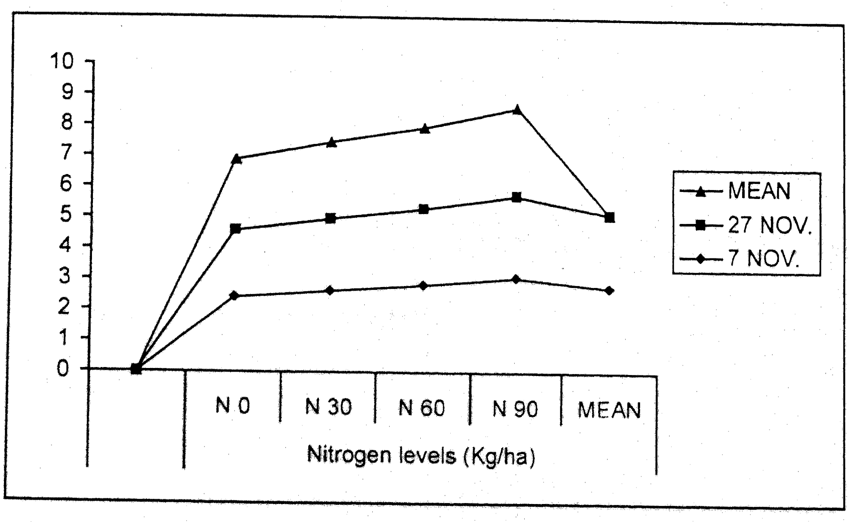
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	2.42	2.63	2.85	3.09	**2.75**
27 NOV.	2.17	2.34	2.46	2.65	**2.40**
MEAN	**2.29**	**2.48**	**2.65**	**2.87**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**
C.D. 5%	0.02	0.01	0.02	0.01	0.03	0.02	**0.02**

Graph-4.31 **Leaf area index at 60 days as influenced by various treatments and their in ateraction (II year)**







date and with highest N-level.

4.1.18 Leaf area index at 90 DAS :

The data in Table 4.32 and 4.33 reveal the similar trend of results under various treatments and their interactions. The treatment interactions were found to be significant in both the years. RD 2552 resulted in significantly higher LAI (2.37 and 3.02 in respective years) over rest of the varieties. However, DL 88 proved to be the second best in this regard (2.28 and 2.85 LAI in respective years). The lowest LAI was recorded in case of K-560 (1.95 and 2.45 in respective years). Late sowing by 20 days discouraged this parameter and increasing N levels encouraged it significantly even at 90 days stage of plant growth. Accordingly, the normal sowing date registered highest LAI (2.32 and 2.89), while late sowing gave the lowest LAI (2.05 and 2.57). Similarly, N_{90} gave the highest LAI (2.40 and 3.00), while No gave the lowest LAI (1.97 and 2.46 in the respective years). The best treatment interaction was RD 2552 sown on normal date and applied with highest level of nitrogen (N_{90}). The highest LAI values were 2.85 in first year and 3.42 in the second year in this treatment interactions. These Treatments were found the best under their respective combinations i.e. varieties x nitrogen, varieties x sowing dates and nitrogen x sowing dates.

Table 4.32 Leaf area index at 90 days as influenced by various treatments and their interaction (I year)

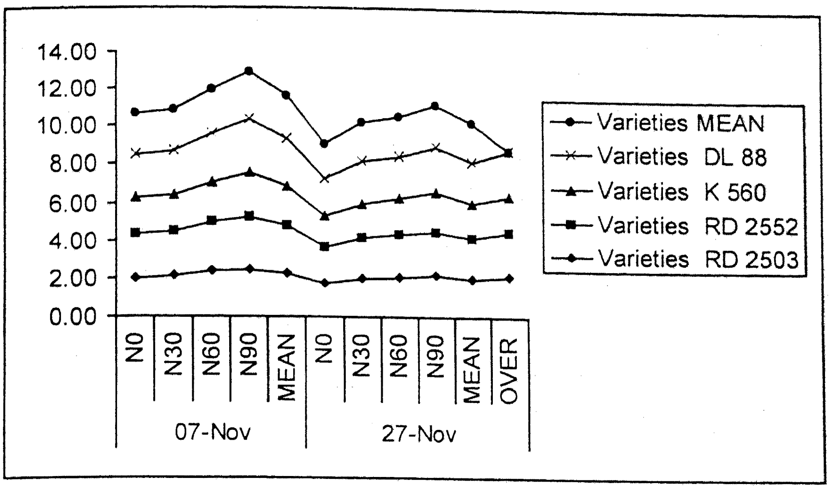
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	2.01	2.37	1.91	2.21	**2.13**
	N_{30}	2.11	2.38	1.94	2.27	**2.17**
	N_{60}	2.37	2.64	2.07	2.48	**2.39**
	N_{90}	2.44	2.85	2.28	2.75	**2.58**
	MEAN	**2.24**	**2.56**	**2.05**	**2.43**	**2.32**
27-Nov	N_0	1.72	1.97	1.62	1.92	**1.81**
	N_{30}	2.01	2.18	1.81	2.16	**2.04**
	N_{60}	2.07	2.28	1.92	2.17	**2.11**
	N_{90}	2.18	2.34	2.08	2.33	**2.23**
	MEAN	**1.99**	**2.19**	**1.86**	**2.14**	**2.05**
	OVER ALL MEAN	**2.11**	**2.37**	**1.95**	**2.28**	

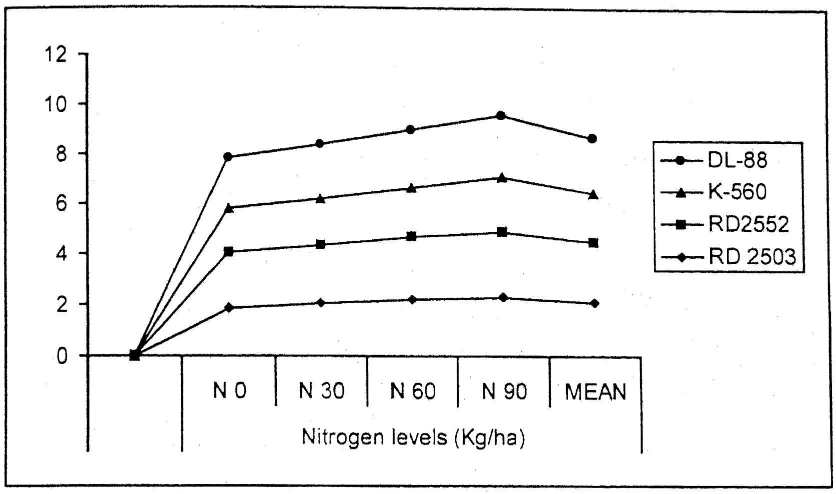
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	1.86	2.06	2.22	2.31	**2.11**
RD2552	2.17	2.28	2.46	2.59	**2.37**
K-560	1.76	1.86	1.99	2.18	**1.95**
DL-88	2.06	2.21	2.32	2.54	**2.28**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	2.13	2.17	2.39	2.58	**2.32**
27 NOV.	1.81	2.04	2.11	2.23	**2.05**
MEAN	**1.97**	**2.10**	**2.25**	**2.40**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.01	0.01	0.02	0.02	0.02
C.D. 5%	0.03	0.02	0.03	0.02	0.05	0.03	0.03

Graph-4.32 Leaf area index at 90 days as influenced by various treatments and their in ateraction (I year)





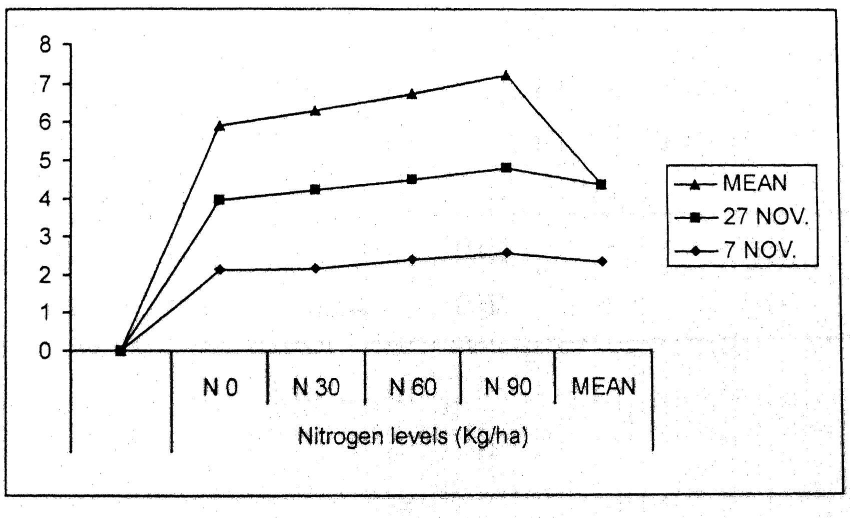


Table 4.33 Leaf area index at 90 daysas influenced by various treatments and their interaction (II year)

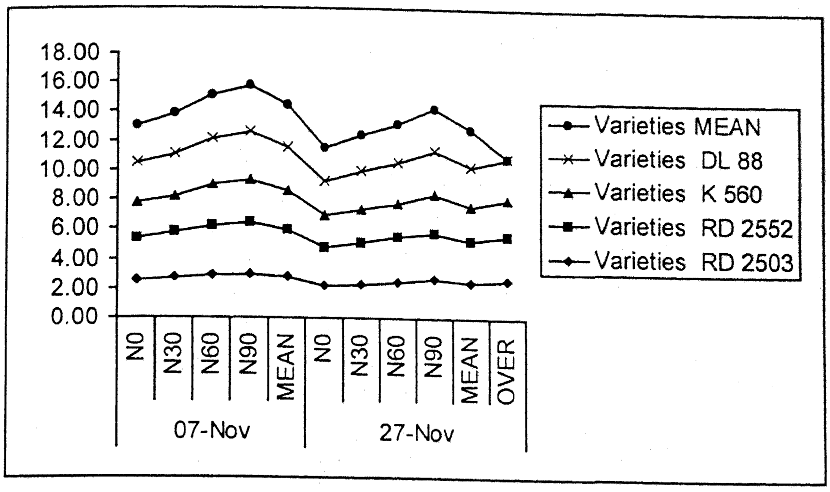
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	2.52	2.88	2.33	2.73	**2.61**
	N_{30}	2.72	3.02	2.43	2.93	**2.77**
	N_{60}	2.91	3.29	2.80	3.11	**3.03**
	N_{90}	2.98	3.42	2.92	3.30	**3.15**
	MEAN	**2.78**	**3.15**	**2.62**	**3.02**	**2.89**
27-Nov	N_0	2.22	2.60	2.12	2.33	**2.32**
	N_{30}	2.33	2.82	2.22	2.60	**2.49**
	N_{60}	2.50	3.02	2.23	2.81	**2.64**
	N_{90}	2.72	3.10	2.61	2.99	**2.85**
	MEAN	**2.44**	**2.88**	**2.29**	**2.68**	**2.57**
OVER ALL MEAN		**2.61**	**3.02**	**2.45**	**2.85**	

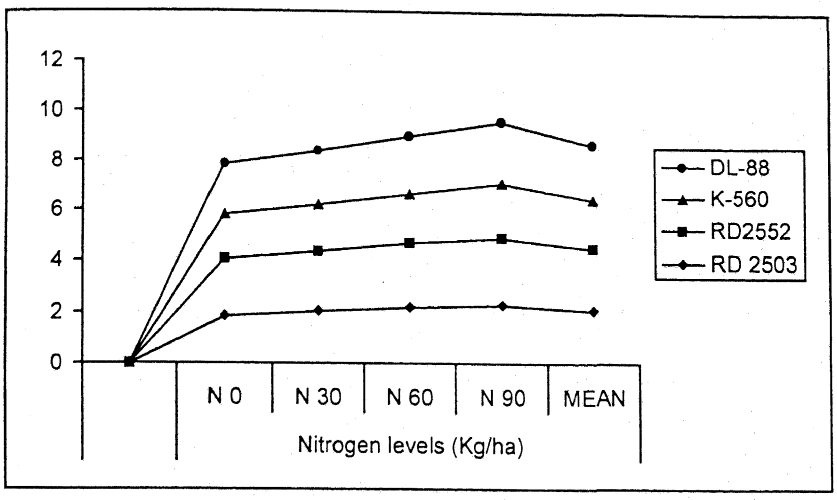
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	2.37	2.52	2.70	2.85	**2.61**
RD2552	2.74	2.92	3.15	3.26	**3.02**
K-560	2.22	2.32	2.51	2.76	**2.45**
DL-88	2.53	2.76	2.96	3.14	**2.85**

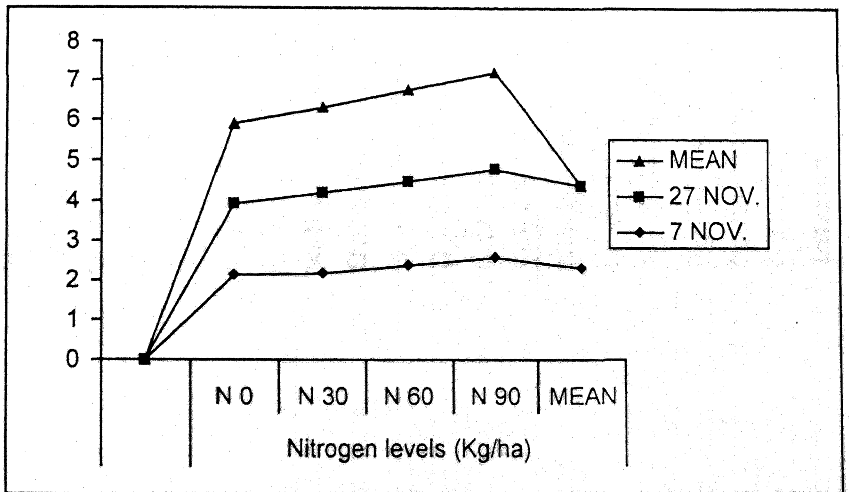
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	2.61	2.77	3.03	3.15	**2.89**
27 NOV.	2.32	2.49	2.64	2.85	**2.57**
MEAN	**2.46**	**2.63**	**2.83**	**3.00**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.02	0.02	0.03	0.02	0.02
C.D. 5%	0.04	0.02	0.04	0.03	0.06	0.04	0.04

Graph-4.33 **Leaf area index at 90 days as influenced by various treatments and their in ateraction (II year)**







Summary table -4.34

Leaf area index/plant under different growth intervals

Treatments	Leaf area index/plant								
Main plot treatments	30 Days			60 Days			90 Days		
Varieties	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean
V_1-(R.D.2503)	00.79	01.03	**00.91**	01.97	02.52	**02.24**	02.11	02.61	**02.36**
V_2-(R.D.2552)	00.87	01.13	**01.00**	02.19	02.82	**02.50**	02.37	03.02	**02.69**
V_3-(K.560)	00.72	00.95	**00.83**	01.84	02.28	**02.06**	01.95	02.45	**02.20**
V_4-(DL.88)	00.83	01.08	**00.95**	02.13	02.67	**02.40**	02.28	02.85	**02.56**
C.D.(5%)	00.04	00.02	**00.03**	00.07	00.01	**00.04**	00.03	00.04	**00.03**
Sub plot treatments									
Date of sowing									
D_1-(7th November)	00.92	01.17	**01.04**	02.20	02.75	**02.47**	02.32	02.89	**02.60**
D_2-(27th November)	00.69	00.92	**00.80**	01.87	02.40	**02.13**	02.05	02.57	**02.31**
C.D.(5%)	00.01	00.01	**00.01**	00.05	00.01	**00.03**	00.02	00.02	**00.04**
Sub sub plot treatments									
Nitrogen levels (Kg/ha.)									
N_1-(Control)	00.70	00.95	**00.82**	01.81	02.29	**02.05**	01.97	02.46	**02.21**
N_2-(30 Kg/ha.)	00.76	01.01	**00.88**	01.93	02.48	**02.20**	02.10	02.63	**02.36**
N_3-(60 Kg/ha.)	00.84	01.08	**00.96**	02.12	02.65	**02.38**	02.25	02.83	**02.54**
N_4-(90 Kg/ha.)	00.91	01.14	**01.02**	02.28	02.87	**02.57**	02.40	03.00	**02.70**
C.D.(5%)	00.03	00.01	**00.02**	00.04	00.01	**00.02**	00.02	00.03	**00.02**
Interaction									
VxD	N.S.	N.S.		N.S.	00.02		00.03	00.04	
VxN	N.S.	00.02		N.S.	00.03		00.05	00.06	
DxN	N.S.	N.S.		N.S.	00.02		00.03	00.04	
VxDxN	N.S.	N.S.		N.S.	00.02		00.03	00.04	

4.1.19 Leaf area index under different growth ~~intervals~~ :

Leaf area index ~~was~~ have also summerized in Table 4.34 covering the mean values of both the years. The LAI was found to enhance very fast during 30 and 60 days period at every stage of growth, however, such enhancement became slow thereafter.

LAI was found maximum in RD 2552, followed by DL-88 and then RD 2503, the lowest being in case of K 560 at every stage of growth. Late sown conditions remained unfavourable for LAI at every stage, however, nitrogen levels remained quite favourable for LAI at every stage of growth. The treatment interactions were found to be non-significant at every stage of observation i.e. 30, 60 and 90 days of plant growth.

4.1.20 Fresh weight/plant at 30 DAS :

The fresh weight per plant was influenced due to various treatments but not due to treatment interactions in both the years (Table 4.35 and 4.36). The variety RD 2552 recorded significantly higher fresh weight (13.16 and 20.14 g/plant in respective years) as compared to all the rest of the varities. This was followed by DL 88 (11.90 and 18.82 g/plant). The lowest value was obtained in case of K-560 (9.63 and 15.02 g/blant). The higher fresh weight was 11.62 g in first year and 17.96 g in second year at the normal sowing date over late sowing. Increasing levels of nitrogen increased

Table 4.35 **Fresh weight/plant at 30 days as influenced by various treatments and their interaction (I year)**

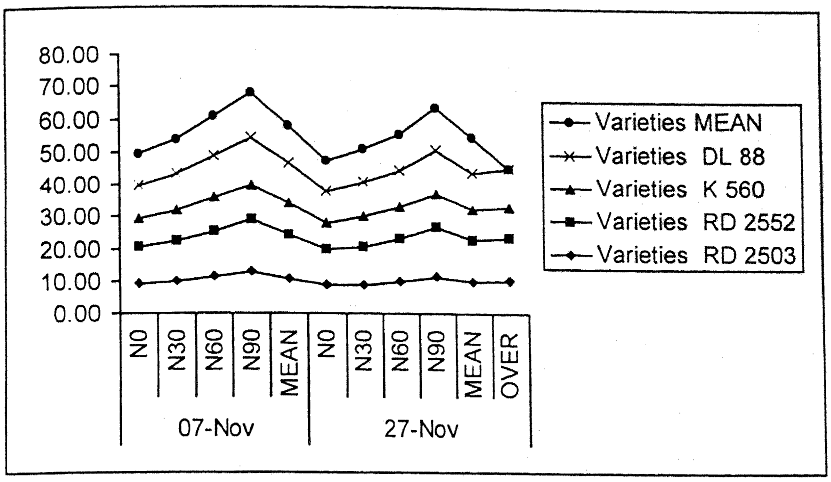
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	9.25	11.45	8.55	10.52	**9.94**
	N_{30}	9.75	12.65	9.46	11.34	**10.80**
	N_{60}	11.46	13.71	10.62	12.91	**12.18**
	N_{90}	12.83	16.10	10.84	14.48	**13.56**
	MEAN	**10.82**	**13.48**	**9.87**	**12.31**	**11.62**
27-Nov	N_0	8.66	11.06	8.06	10.02	**9.45**
	N_{30}	8.92	11.79	9.32	10.81	**10.21**
	N_{60}	10.01	13.26	9.82	11.34	**11.11**
	N_{90}	11.39	15.30	10.31	13.78	**12.69**
	MEAN	**9.75**	**12.85**	**9.63**	**11.49**	**10.86**
OVER ALL MEAN		**10.28**	**13.16**	**9.63**	**11.90**	

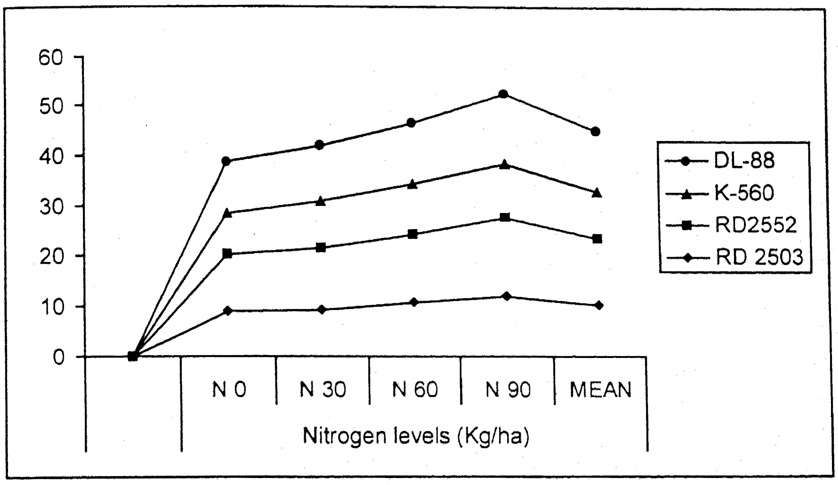
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	8.95	9.33	10.73	12.11	**10.28**
RD2552	11.25	12.22	13.48	15.70	**13.16**
K-560	8.31	9.39	10.22	10.57	**9.63**
DL-88	10.27	11.07	12.12	14.13	**11.90**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	9.94	10.80	12.18	13.56	**11.62**
27 NOV.	9.45	10.21	11.11	12.69	**10.86**
MEAN	**9.69**	**10.50**	**11.64**	**13.12**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em(.)±	0.11	0.14	0.27	0.12	0.23	0.16	0.20
C.D. 5%	0.26	0.32	N.S.	0.23	0.47	N.S.	N.S.

Graph-4.35 **Fresh weight/plant at 30 days as influenced by various treatments and their inateraction (I year)**





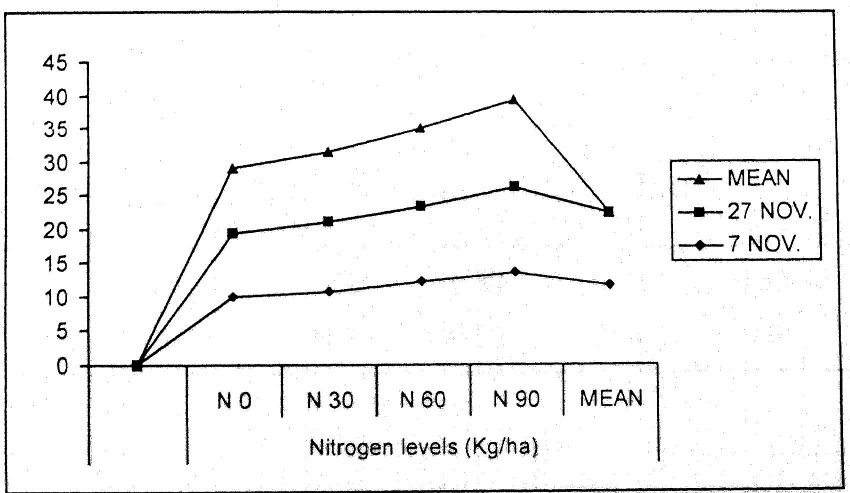


Table 4.36 **Fresh weight/plant at 30 days as influenced by various treatments and their interaction (II year)**

Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	14.61	17.54	13.57	16.39	**15.33**
	N_{30}	15.87	19.45	14.45	18.30	**17.02**
	N_{60}	17.51	21.68	16.41	20.54	**19.03**
	N_{90}	18.43	23.62	16.71	22.27	**20.26**
	MEAN	**16.60**	**20.57**	**15.28**	**19.37**	**17.96**
27-Nov	N_0	13.46	17.63	13.56	15.61	**15.01**
	N_{30}	14.46	18.45	13.52	16.53	**15.74**
	N_{60}	16.27	20.32	15.63	19.41	**17.91**
	N_{90}	17.37	22.46	16.36	21.59	**19.44**
	MEAN	**15.39**	**19.71**	**14.77**	**18.28**	**17.04**
OVER ALL MEAN		**16.00**	**20.14**	**15.02**	**18.82**	

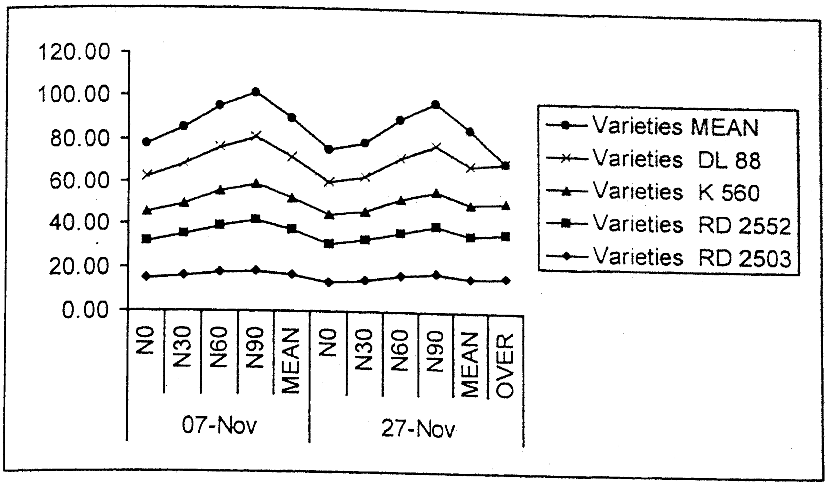
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	14.03	15.16	16.89	17.90	**16.00**
RD2552	17.58	18.95	21.00	23.04	**20.14**
K-560	13.56	13.98	16.02	16.53	**15.02**
DL-88	16.00	17.41	19.97	21.93	**18.82**

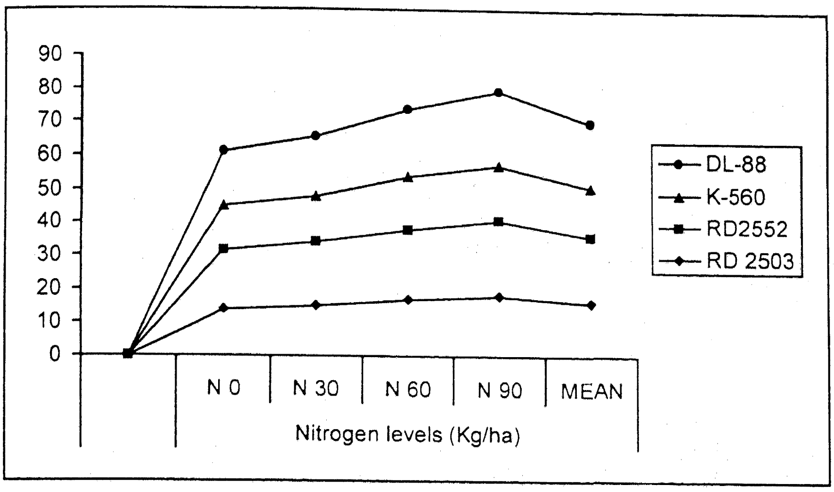
Nitrogen levels (Kg/ha)

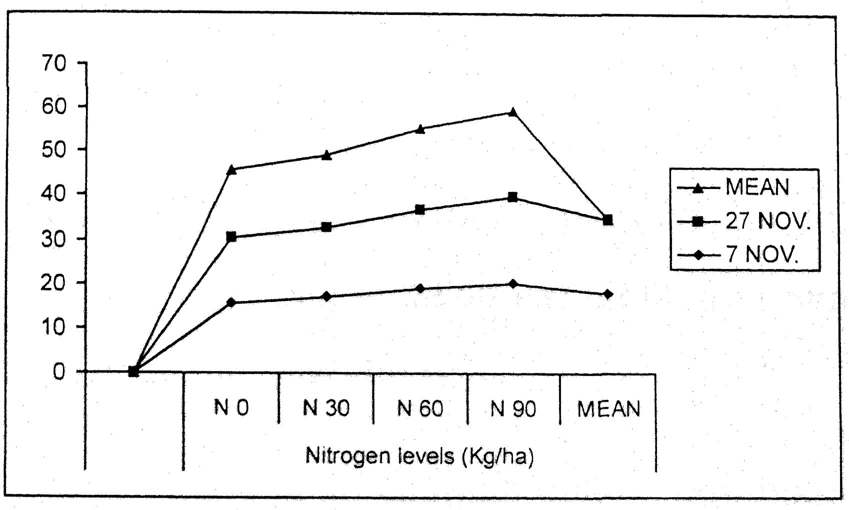
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	15.53	17.02	19.03	20.26	**17.96**
27 NOV.	15.01	15.74	17.91	19.44	**17.04**
MEAN	**15.27**	**16.38**	**18.47**	**19.85**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.18	0.33	0.66	0.39	0.78	0.55	0.58
C.D. 5%	0.43	0.76	N.S.	0.73	N.S.	N.S.	N.S.

Graph-4.36 Fresh weight/plant at 30 days as influenced by various treatments and their inateraction (II year)







the fresh weight significantly, however late sowing by 20 days decreased the fresh weight significantly.

As such, the highest fresh weight was 13.12g in first year and 19.85 g in second year due to highest level of nitrogen (N_{90}). On the other hand, the lowest fresh weight was 9.69 and 15.27g in the respective year under no nitrogen (No).

4.1.21 Fresh weight/plant at 60 DAS :

The fresh weight was found to deviate significantly due to varieties, sowing dates and N-levels but not due to treatment interactions except in case of varieties x N-levels. (Table 4.37 and 4.38). RD 2552 gave significantly higher fresh weight (61.28 and 68.43 g in the respective years) over rest the varieties. The second best was DL-88 and then RD 2503. The lowest values were obtained in case of K-560 (35.14 and 42.39 g in the respective years).

Late sowing significantly reduced the fresh weight over normal sowing. The influence of N-levels continued to be encouraging significantly at this stage also. Accordingly, the highest N-level resulted in the highest fresh weight i.e. 57.60 and 65.91 g in the respective years. Amongst the interactions, RD 2552 with N_{90} gave significantly higher fresh weight (73.60 and 82.00 g in respective years) over rest of the interactions.

Table 4.37 Fresh weight/plant at 60 days as influenced by various treatments and their interaction (I year)

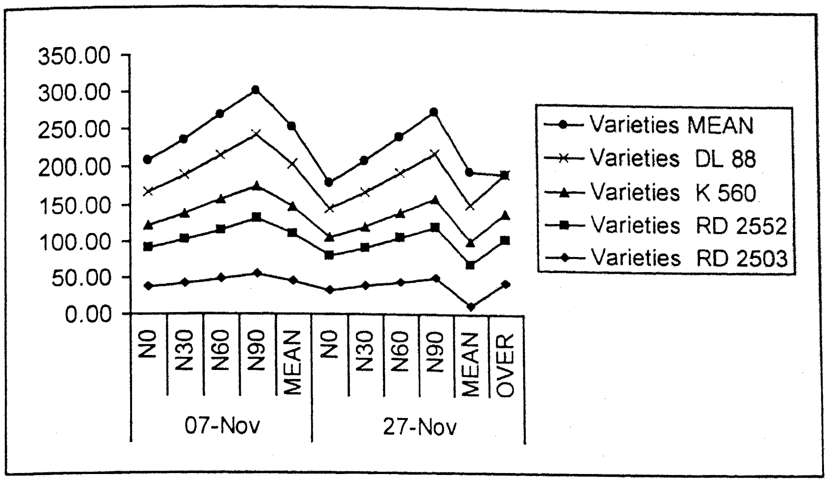
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	37.46	53.48	31.56	44.51	**41.75**
	N_{30}	42.46	59.77	36.33	50.41	**47.24**
	N_{60}	48.38	67.61	41.38	58.27	**53.91**
	N_{90}	54.45	76.60	44.30	66.45	**60.45**
	MEAN	**45.69**	**64.36**	**38.39**	**54.91**	**50.84**
27-Nov	N_0	32.34	47.38	25.86	38.46	**36.01**
	N_{30}	38.32	52.43	29.61	46.41	**41.69**
	N_{60}	43.43	62.39	33.60	53.50	**48.23**
	N_{90}	50.56	70.61	38.51	59.38	**54.76**
	MEAN	**11.16**	**58.20**	**31.89**	**49.44**	**45.17**
	OVER ALL MEAN	**43.42**	**61.28**	**35.14**	**52.17**	

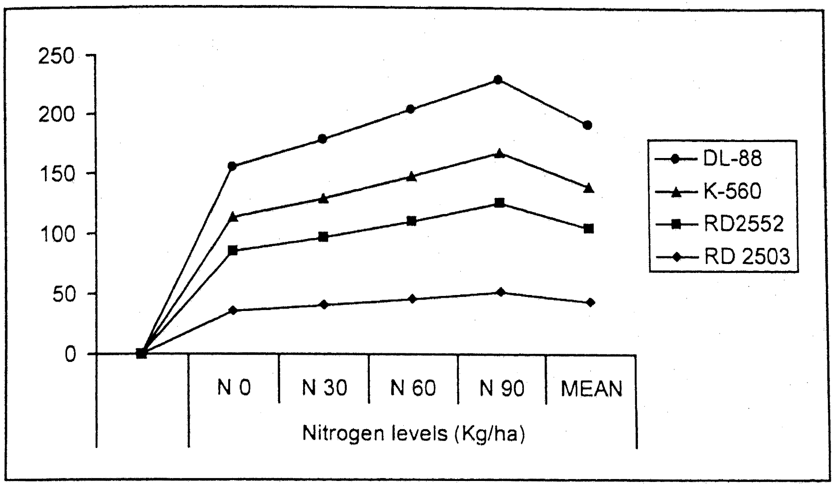
Varieties	**Nitrogen levels (Kg/ha)** N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	34.90	40.39	45.90	52.50	**43.42**
RD2552	50.43	56.10	65.00	73.60	**61.28**
K-560	28.71	32.97	37.49	41.44	**35.14**
DL-88	41.48	48.41	55.88	62.91	**52.17**

Date of sowing	**Nitrogen levels (Kg/ha)** N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	41.75	47.24	53.91	60.45	**50.84**
27 NOV.	36.01	41.69	48.23	54.76	**45.17**
MEAN	**38.88**	**44.46**	**51.07**	**57.60**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	1.21	0.76	1.52	0.92	1.58	1.31	1.36
C.D. 5%	2.96	1.75	N.S.	1.56	3.72	N.S.	N.S

Graph-4.37 Fresh weight/plant at 60 days as influenced by various treatments and their inateraction (I year)





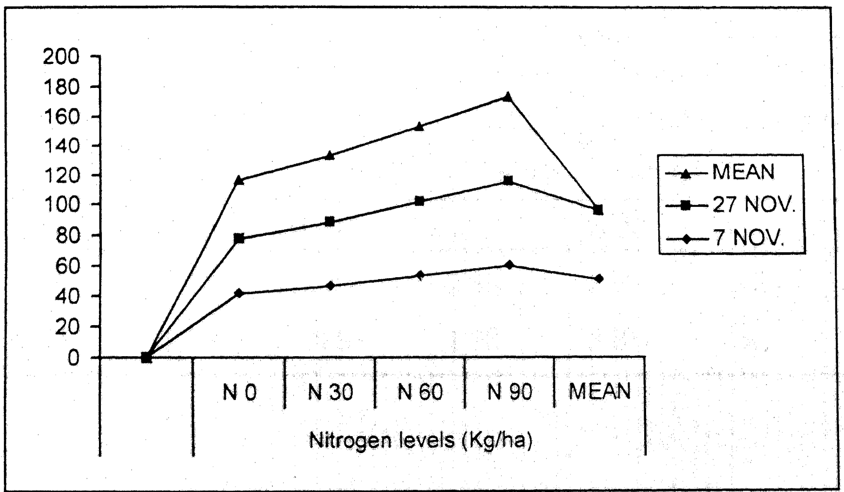


Table 4.38 **Fresh weight/plant at 60 days as influenced by various treatments and their interaction (II year)**

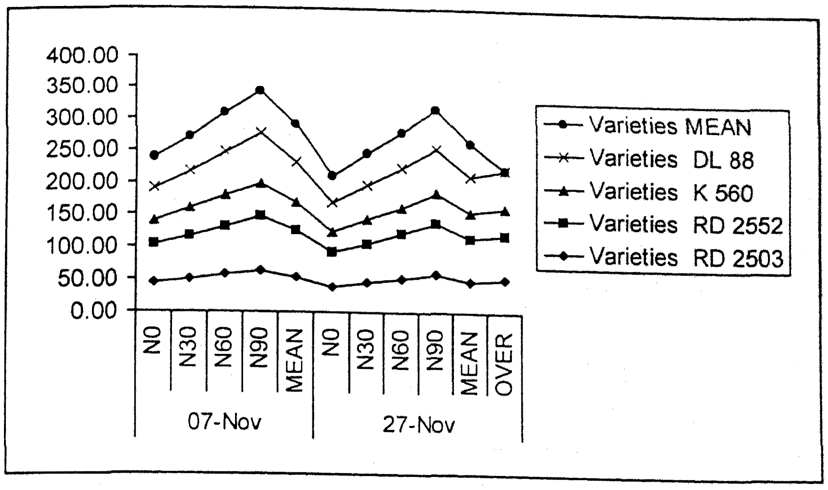
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	43.43	59.23	37.46	50.21	**47.58**
	N_{30}	49.18	66.46	43.29	57.44	**54.09**
	N_{60}	56.23	74.55	49.50	66.40	**61.67**
	N_{90}	62.25	84.46	52.37	75.32	**68.60**
	MEAN	**52.77**	**71.17**	**45.65**	**62.34**	**57.98**
27-Nov	N_0	38.45	53.55	31.25	45.33	**42.14**
	N_{30}	45.31	59.38	38.40	53.50	**49.15**
	N_{60}	51.34	70.33	40.49	61.35	**55.88**
	N_{90}	58.54	79.55	46.42	68.39	**63.22**
	MEAN	**48.41**	**65.70**	**39.14**	**57.14**	**52.60**
OVER ALL MEAN		**50.59**	**68.43**	**42.39**	**59.74**	

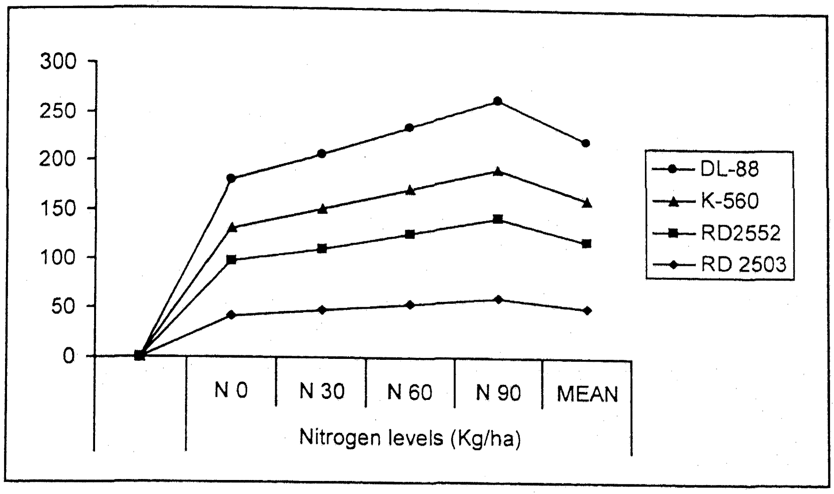
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	40.94	47.24	53.78	60.39	**50.59**
RD2552	56.39	62.92	72.44	82.00	**68.43**
K-560	34.35	40.84	44.99	49.39	**42.39**
DL-88	47.77	55.47	63.87	71.85	**59.74**

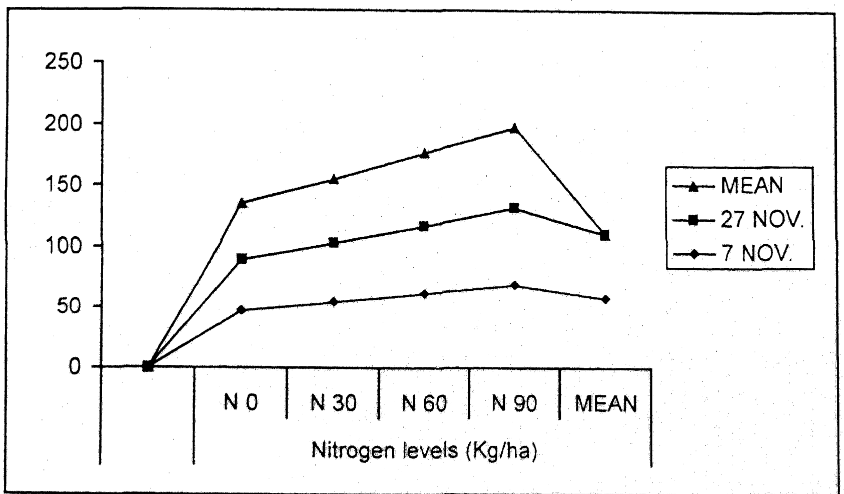
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	47.58	54.09	61.67	68.60	**57.98**
27 NOV.	42.14	49.15	55.88	63.22	**52.60**
MEAN	**44.86**	**51.62**	**58.77**	**65.91**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em(t.) ±	0.96	0.73	1.47	0.95	1.89	1.34	1.37
C.D. 5%	2.35	1.69	N.S.	1.90	3.81	N.S.	N.S.

Graph-4.38 **Fresh weight/plant at 60 days as influenced by various treatments and their inateraction (II year)**







4.1.22 Fresh weight/plant at 90 DAS :

The fresh weight continued to increase, in general, with the advancement of plnat growth from 60 to 90 DAS stage in both the years with the similar effect of various treatments (Table 4.39 and 4.40). The variety RD 2552 registered maximum fresh weight (413.21 g in first year and 421.60 g in second year), being significantly superior to the remaining varieties. The second best variety was DL 88 giving 360.16 and 366.93 g fresh weight in the respective years. the lowest values were obtained in case of K560 (265.09 and 274.05 g). Late sowing significantly decreased the fresh weight while increasing N levels significantly increased the fresh weight. As such the maximum fresh weight at highest N level was 384.28 g in first year and 393.44 g in the second year. All the treatment interactions except nitrogen x sowing dates, were found to be singificant in both the years. As such, the fresh weight was further enhanced significantly (475.69 and 485.19 g in respective years) when RD 2552 was sown on normal date (7 November) and applied with highest N-level (N_{90}). On the other hand, the fresh weight was quite minimum only 194.37 and 202.70 g when K-560 was sown late by 20 days without applying any nitrogen.

Table 4.39 **Fresh weight/plant at 90 days as influenced by various treatments and their interaction (I year)**

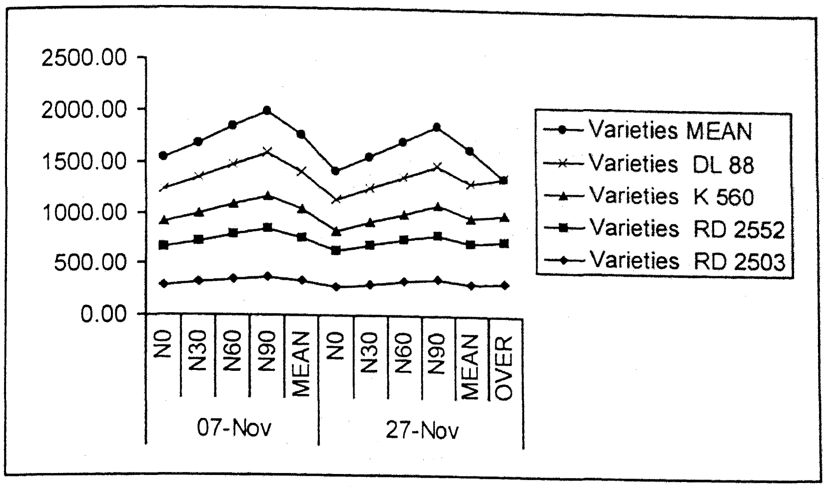
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	290.42	379.44	244.78	327.79	**310.61**
	N_{30}	323.49	403.64	271.43	352.98	**337.88**
	N_{60}	346.37	446.64	298.27	384.44	**368.93**
	N_{90}	371.71	475.69	324.28	418.38	**397.51**
	MEAN	**333.00**	**426.35**	**284.69**	**370.90**	**353.73**
27-Nov	N_0	270.94	360.93	194.37	308.40	**283.66**
	N_{30}	302.51	383.46	231.69	329.43	**311.77**
	N_{60}	327.86	412.91	262.45	364.50	**341.93**
	N_{90}	352.39	443.00	293.46	395.40	**371.06**
	MEAN	**313.42**	**400.07**	**245.49**	**349.43**	**327.10**
	OVER ALL MEAN	**323.21**	**413.21**	**265.09**	**360.16**	

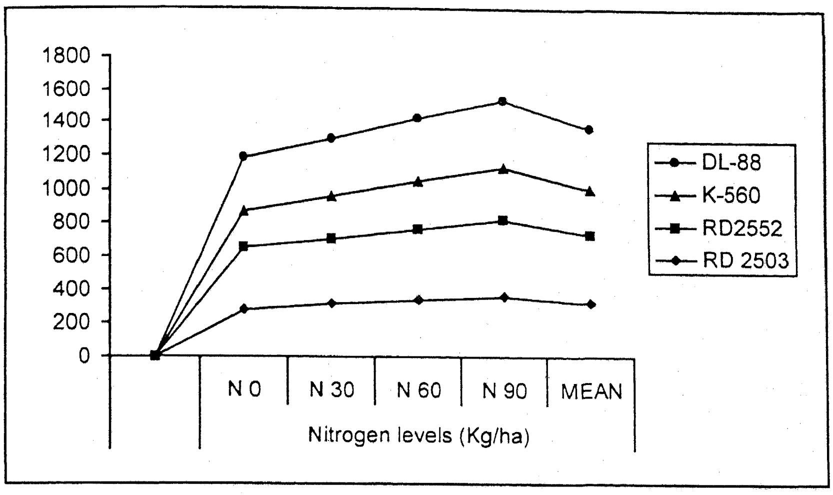
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	280.68	313.00	337.11	362.05	**323.21**
RD2552	370.18	393.55	429.77	459.34	**413.21**
K-560	219.57	251.56	280.36	308.87	**265.09**
DL-88	318.09	341.20	374.47	406.89	**360.16**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	310.61	337.88	368.93	397.51	**353.73**
27 NOV.	283.66	311.77	341.93	371.06	**327.10**
MEAN	**297.13**	**324.82**	**355.43**	**384.28**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.62	0.52	1.03	0.69	1.38	0.98	0.99
C.D. 5%	1.52	1.19	2.39	1.39	2.78	N.S.	2.08

Graph-4.39 Fresh weight/plant at 90 days as influenced by various treatments and their inateraction (I year)





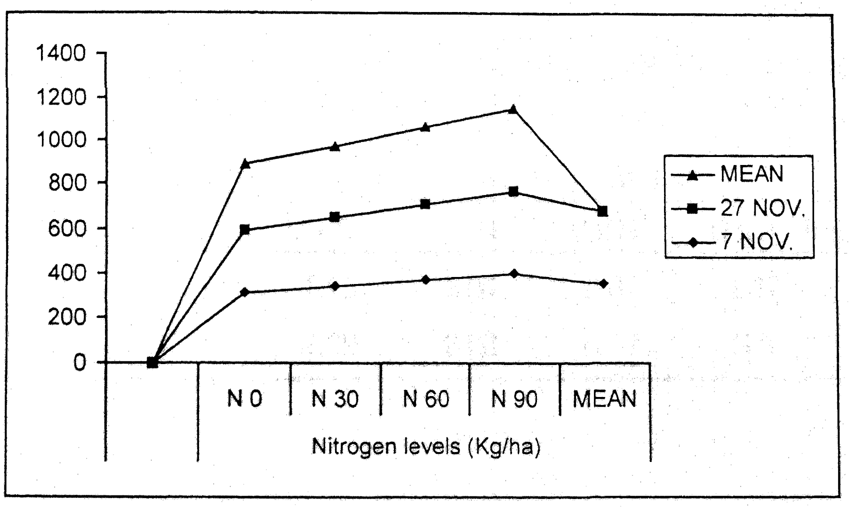


Table 4.40 **Fresh weight/plant at 90 days as influenced by various treatments and their interaction (II year)**

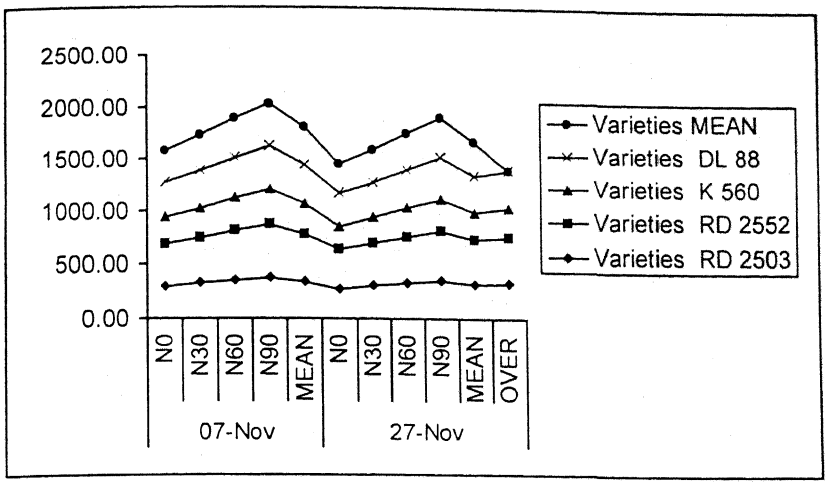
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	297.29	386.36	251.39	332.63	**316.92**
	N_{30}	331.38	413.33	279.48	359.27	**345.86**
	N_{60}	355.11	455.14	308.36	391.23	**377.46**
	N_{90}	381.44	485.19	334.48	426.08	**406.80**
	MEAN	**341.30**	**435.00**	**293.43**	**377.30**	**361.76**
27-Nov	N_0	278.51	368.75	202.70	314.32	**291.07**
	N_{30}	311.70	390.33	239.18	336.31	**319.38**
	N_{60}	336.30	420.30	273.37	372.33	**350.57**
	N_{90}	360.24	453.40	303.44	403.29	380.09
	MEAN	**321.69**	**408.19**	**254.67**	**356.56**	**335.28**
	OVER ALL MEAN	**331.49**	**421.60**	**274.05**	**366.93**	

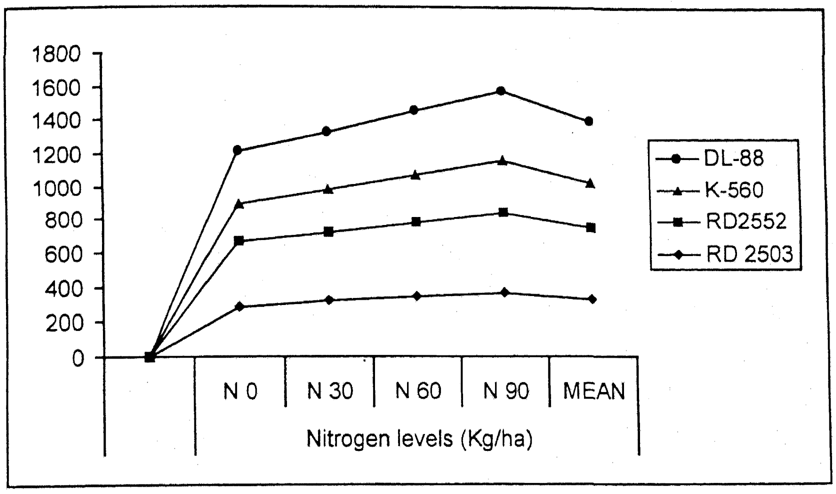
Varieties	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
	Nitrogen levels (Kg/ha)				
RD 2503	287.90	321.54	345.70	370.84	**331.49**
RD2552	377.55	401.83	437.72	469.29	**421.60**
K-560	227.04	259.33	290.86	318.96	**274.05**
DL-88	323.47	347.79	381.78	414.68	**366.93**

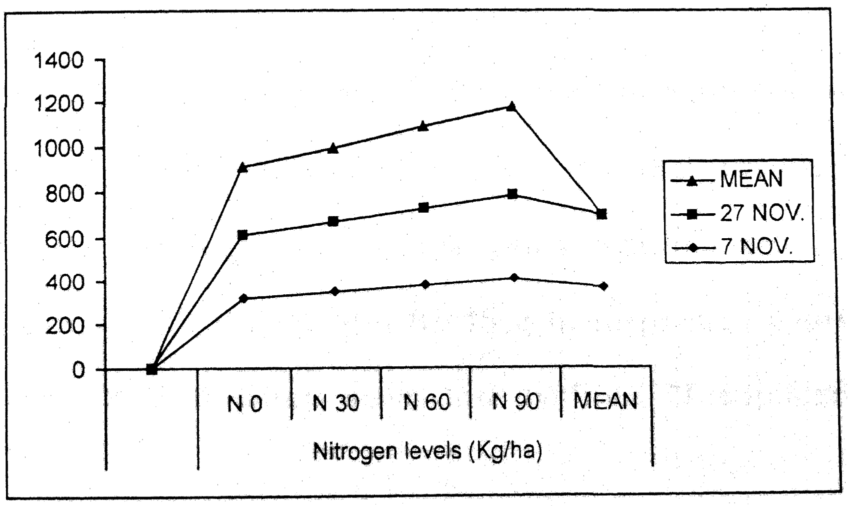
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
	Nitrogen levels (Kg/ha)				
7 NOV.	316.92	345.86	377.46	406.80	**361.76**
27 NOV.	291.07	319.38	350.57	380.09	**335.28**
MEAN	**303.99**	**332.62**	**364.01**	**393.44**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.12	0.63	1.25	1.04	2.07	1.47	1.42
C.D. 5%	2.75	1.45	2.89	2.08	4.17	N.S.	2.93

Graph-4.40 **Fresh weight/plant at 90 days as influenced by various treatments and their inateraction (II year)**







4.1.23 Fresh weight/plant at harvest :

The fresh weight/plant was, in general, declined between 90 DAS and harvest stages in both the years along with the same trend of results due to various treatments (Table 4.41 and 4.42). The separate effect of treatments as well as treatment interactions exerted significant influence upon fresh weight even at the harvest stage of crop. RD 2552 recorded significantly higher fresh weight 184.96 and 193.59 g as compared to DL 88 and RD 2503 and K 560 varieties. The second best was DL 88. The lowest fresh weight was 98.15 and 106.85 g in case of K 560 variety in both the years. Late sown crop recorded significantly lower fresh weight as compared to the normal sown crop. Increasing levels of nitrogen brought about significant increase in the fresh weight. Accordingly, the maximum fresh weight was 172.74 g in first year and 182.26 g in the second year at N_{90} level of nitrogen. Amongst the treatment interactions, RD 2552 sown at normal date and applied with maximum nitrogen level (N_{90}) resulted in significantly higher fresh weight (225.20 and 235.21 g in respective years) over all the rest of the interactions. Similarly, RD 2552 either with normal sowing date or with N_{90} also performed the best. Normal sowing x N_{90} also performed the best in both the years. On the other hand, the least fresh weight (72.21 and 83.48 g in respective years) was obtained from K 560 when sown late without N application.

Table 4.41 **Fresh weight/plant at harvesting as influenced by various treatments and their interaction (I year).**

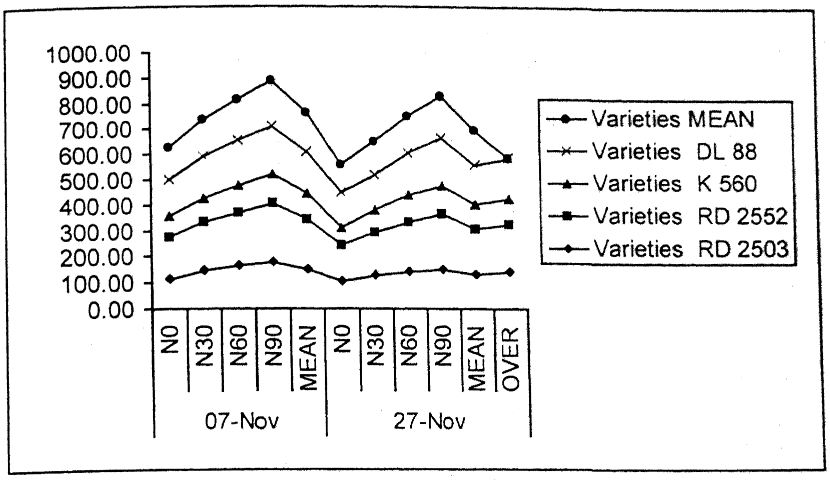
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	115.18	158.24	85.23	142.34	**125.25**
	N_{30}	148.14	185.15	95.19	163.30	**147.94**
	N_{60}	165.17	206.17	106.44	176.36	**164.22**
	N_{90}	181.19	225.20	116.28	190.21	**179.23**
	MEAN	**152.42**	**193.69**	**98.15**	**168.05**	**154.16**
27-Nov	N_0	106.23	135.14	72.21	134.28	**111.96**
	N_{30}	128.17	163.29	87.17	141.20	**129.96**
	N_{60}	140.18	194.32	103.68	165.37	**150.89**
	N_{90}	153.26	212.23	112.28	187.25	**166.25**
	MEAN	**131.96**	**176.24**	**93.83**	**157.02**	**139.76**
OVER ALL MEAN		**142.19**	**184.96**	**98.15**	**162.53**	

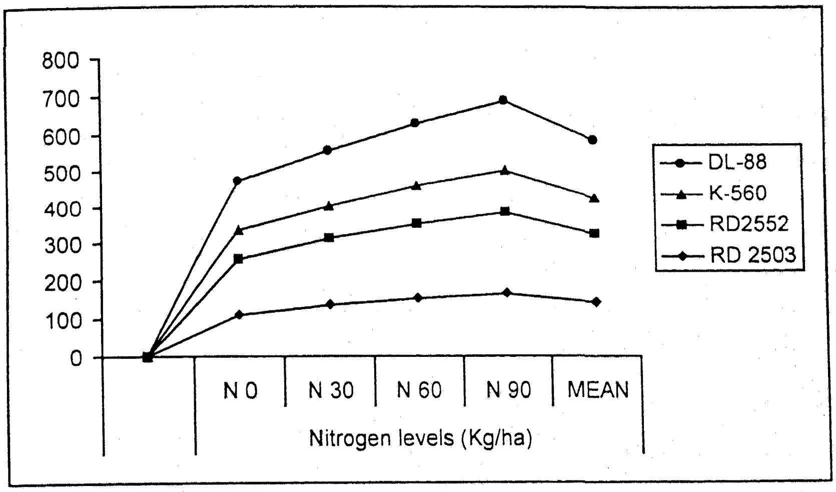
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	110.70	138.15	152.67	167.22	**142.19**
RD2552	146.69	174.22	200.24	218.71	**184.96**
K-560	78.72	91.18	106.44	116.28	**98.15**
DL-88	138.31	152.25	170.86	188.73	**162.53**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	125.25	147.94	164.22	179.23	**154.16**
27 NOV.	111.96	129.96	150.89	166.25	**139.76**
MEAN	**118.60**	**138.95**	**157.55**	**172.74**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.01	0.70	1.39	0.82	1.65	1.16	1.22
C.D. 5%	2.48	1.61	3.21	1.66	3.31	3.34	2.58

Graph-4.41 **Fresh weight/plant at harvesting as influenced by various treatments and their inateraction (I year)**





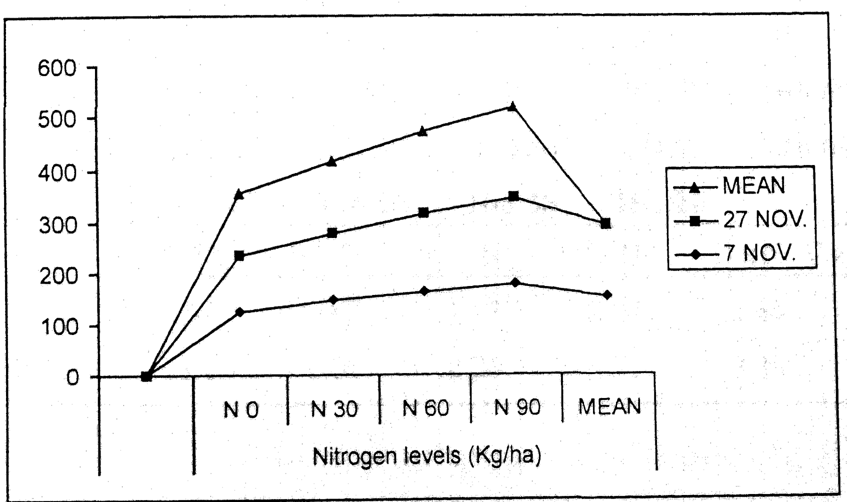


Table 4.42 **Fresh weight/plant at harvesting as influenced by various treatments and their interaction (II year).**

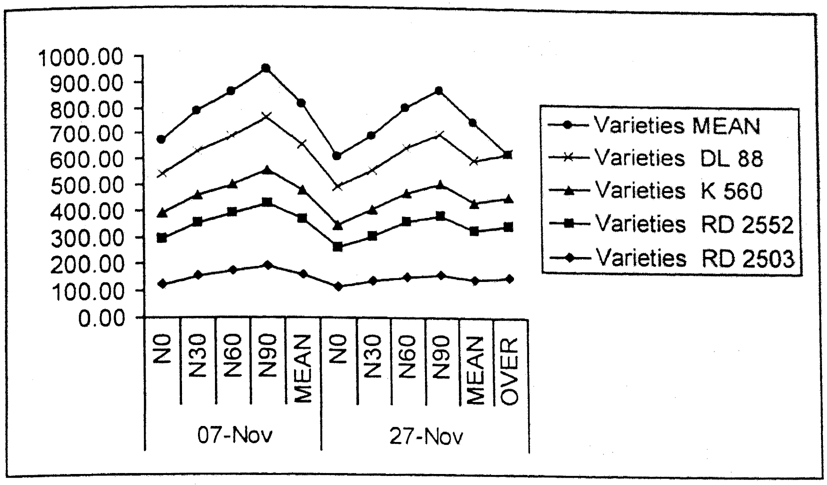
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	124.41	167.11	96.20	152.29	**135.00**
	N_{30}	157.30	196.21	104.76	172.14	**157.60**
	N_{60}	174.35	214.35	112.34	188.33	**172.34**
	N_{90}	192.13	235.21	128.25	203.61	**189.80**
	MEAN	**162.05**	**203.22**	**110.39**	**179.09**	**163.69**
27-Nov	N_0	114.24	146.46	83.48	145.26	**122.36**
	N_{30}	139.26	165.37	97.89	153.15	**138.92**
	N_{60}	153.57	202.90	110.55	174.42	**160.36**
	N_{90}	161.15	221.11	121.30	195.32	**174.72**
	MEAN	**142.05**	**183.96**	**103.30**	**167.04**	**149.09**
OVER ALL MEAN		**152.05**	**193.59**	**106.85**	**173.06**	

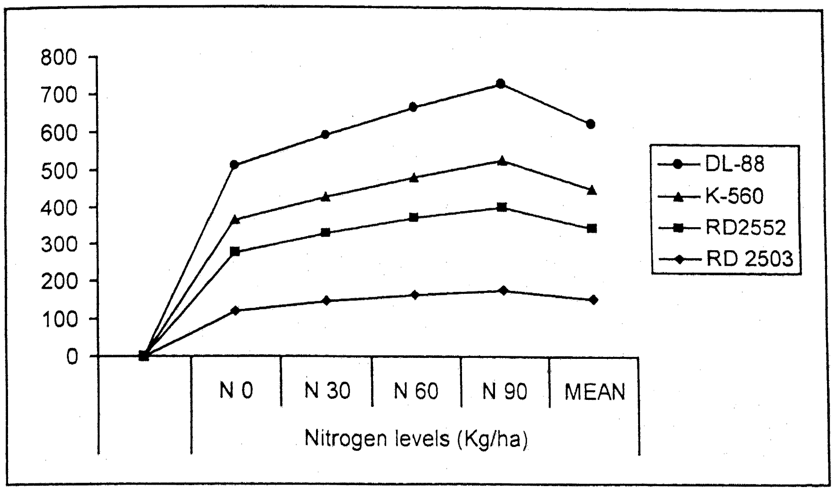
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	119.32	148.28	163.96	176.64	**152.05**
RD2552	156.78	180.79	208.62	228.16	**193.59**
K-560	89.84	101.32	111.44	124.77	**106.85**
DL-88	148.77	162.64	181.37	199.46	**173.06**

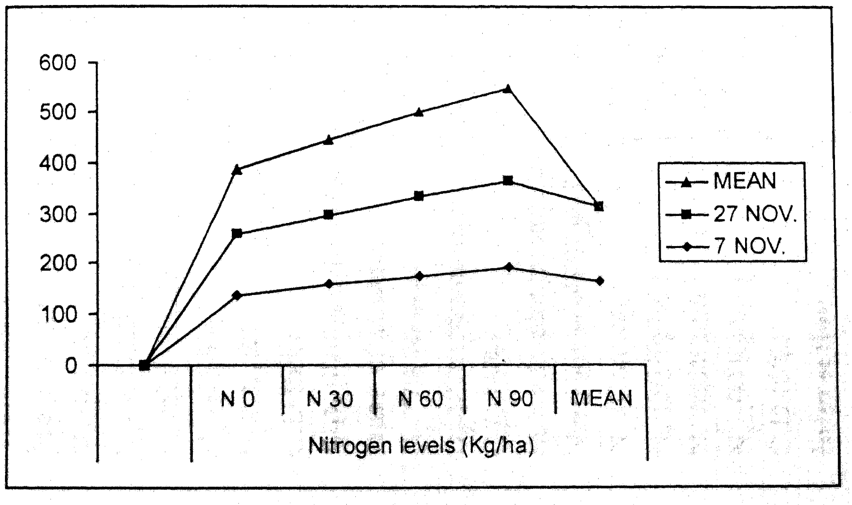
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	135.00	157.60	172.34	189.80	**163.69**
27 NOV.	122.36	138.92	160.36	174.72	**149.09**
MEAN	**128.68**	**148.26**	**166.35**	**182.26**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.11	0.44	0.87	1.17	2.34	1.66	1.50
C.D. 5%	2.72	1.01	2.01	2.36	4.71	3.33	3.05

Graph-4.42 **Fresh weight/plant at harvesting as influenced by various treatments and their inateraction (II year)**







Summary table -4.43
Fresh weight/plant at different growth intervals

Treatments	Fresh weight/plant (gm)											
Main plot treatments	30 Days			60 Days			90 Days			Maturity		
Varieties	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean
V_1-(R.D.2503)	10.28	16.00	**13.14**	43.42	50.59	**47.00**	323.21	331.49	**327.35**	142.19	152.05	**147.12**
V_2-(R.D.2552)	13.16	20.14	**16.65**	61.28	68.43	**64.85**	413.21	421.60	**417.40**	184.96	193.59	**189.27**
V_3-(K.560)	09.63	15.02	**12.32**	35.14	42.39	**38.76**	265.09	274.05	**369.57**	98.15	106.85	**102.50**
V_4-(DL.88)	11.90	18.82	**15.36**	52.17	59.74	**55.95**	360.16	366.93	**363.54**	162.53	173.06	**167.80**
C.D.(5%)	00.26	00.43	**00.34**	02.96	02.35	**02.65**	01.52	02.75	**02.13**	02.48	02.72	**02.60**
Sub plot treatments												
Date of sowing												
D_1-(7th November)	11.62	17.96	**14.79**	50.84	57.98	**54.41**	353.73	361.76	**357.74**	154.16	163.69	**158.92**
D_2-(27th November)	10.86	17.04	**13.95**	45.17	52.60	**48.88**	327.10	335.28	**331.19**	139.76	149.09	**144.42**
C.D.(5%)	00.32	00.76	**00.54**	01.75	01.69	**01.72**	01.19	01.45	**01.32**	01.61	01.01	**00.80**
Sub sub plot treatments												
Nitrogen levels (Kg/ha.)												
N_1-(Control)	09.69	15.27	**12.48**	38.88	44.86	**41.87**	297.13	303.99	**300.56**	118.60	128.68	**123.64**
N_2-(30 Kg/ha.)	10.50	16.38	**13.44**	44.46	51.62	**48.04**	324.82	332.62	**328.72**	138.95	148.26	**143.60**
N_3-(60 Kg/ha.)	11.64	18.47	**15.05**	51.07	58.77	**54.92**	355.43	364.01	**359.72**	157.55	166.35	**161.95**
N_4-(90 Kg/ha.)	13.12	19.85	**16.48**	57.60	65.91	**61.75**	384.28	393.44	**388.86**	172.74	182.26	**177.50**
C.D.(5%)	00.23	00.78	**00.50**	01.86	01.90	**01.88**	01.39	02.08	**01.73**	01.66	02.36	**02.01**
Interaction												
VxD	N.S.	N.S.		N.S.	N.S.		02.39	02.89		03.21	02.01	
VxN	00.47	N.S.		03.72	03.81		02.78	04.17		03.31	04.71	
DxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		02.34	03.33	
VxDxN	N.S.	N.S.		N.S.	N.S.		02.07	02.93		02.58	03.05	

4.1.24 Fresh weight/plant at different growth intervals :

The fresh weight/plant has been summarised in Table 4.43 covering the mean values of both the years. The fresh weight was enhanced with the enhancement of plant growth upto maturity stage. The increase between 30 and 60 days growth period was round about three fold in different varieties and other treatments, but beyond 60 days and upto 90 days stage, the increase in fresh weight went even upto six to nine fold. Thereafter, it started declining drastically due to lack of succulence in vegetative parts with the advancement of plant development towards maturity stage. RD 2552 recorded highest fresh weight followed by DL-88, and RD 2503 the lowest being in case of K-560 at every stage. Late sown crop by 20 days recorded significantly reduced fresh weight. However, application of nitrogen levels upto N_{90} enhanced this parameter significantly at every stage of growth. The treatment interactins were found to be almost non significant at every stage of observation i.e. 30, 60, 90 days and maturity stages.

4.1.25 Dry weight/plant at 30 DAS :

The dry weight/plant was found to deviate significantly due to different varieties sowing dates and nitrogen levels in both the years. Most of the treatment interactions were also found significant in both the years as revealed from Table 4.44 and 4.45, RD 2552

Table 4.44 **Dry weight/plant at 30 days as influenced by various treatments and their interaction (I year).**

Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	4.00	5.95	3.85	5.12	**4.73**
	N_{30}	4.55	6.25	4.25	5.20	**5.06**
	N_{60}	5.95	7.05	5.64	6.65	**6.32**
	N_{90}	6.50	8.95	5.66	7.65	**7.19**
	MEAN	**5.25**	**7.05**	**4.85**	**6.15**	**5.82**
27-Nov	N_0	3.95	5.05	3.72	5.06	**4.44**
	N_{30}	3.98	5.98	3.02	5.56	**4.63**
	N_{60}	5.02	6.95	4.35	5.20	**5.38**
	N_{90}	5.25	8.05	5.09	7.00	**6.35**
	MEAN	**4.55**	**6.51**	**4.05**	**5.71**	**5.20**
	OVER ALL MEAN	**4.90**	**6.78**	**4.45**	**5.93**	

Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	3.97	4.26	5.48	5.87	**4.90**
RD2552	5.50	6.11	7.00	8.50	**6.78**
K-560	3.78	3.63	4.99	5.37	**4.45**
DL-88	5.09	5.28	5.92	7.32	**5.93**

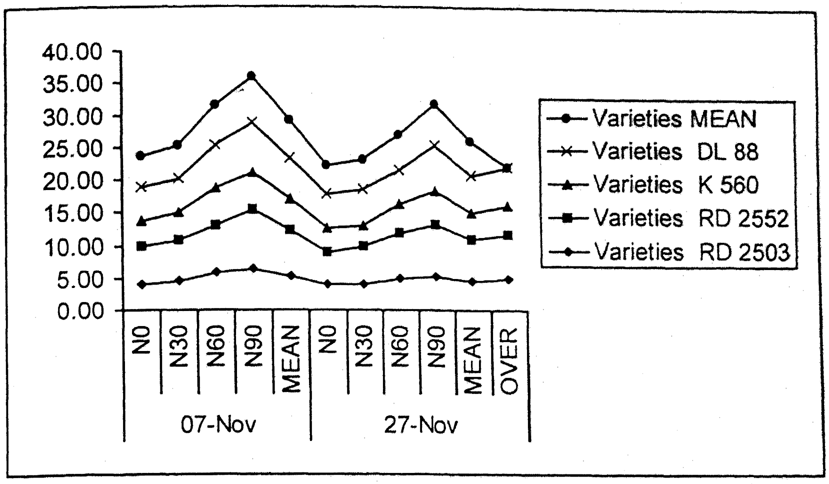
(Nitrogen levels (Kg/ha))

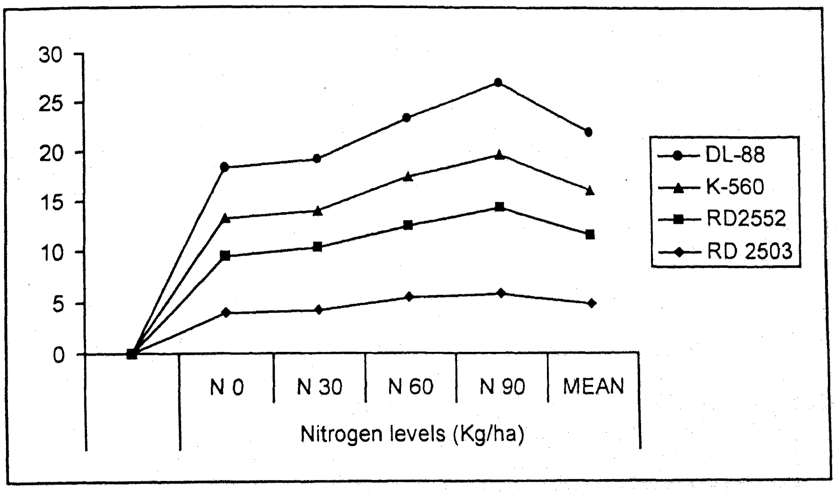
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	4.73	5.06	6.32	7.19	**5.82**
27 NOV.	4.44	4.63	5.38	6.35	**5.20**
MEAN	**4.58**	**4.84**	**5.85**	**6.77**	

(Nitrogen levels (Kg/ha))

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.02	0.01	0.02	0.02	0.02
C.D. 5%	0.02	0.02	0.04	0.02	0.04	0.03	0.03

Graph-4.44 Dry weight/plant at 30 days as influenced by various treatments and their inateraction (I year)





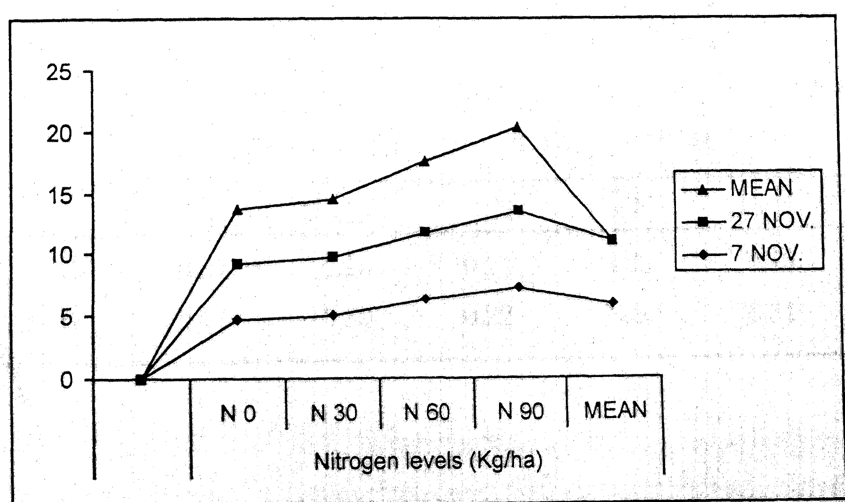


Table 4.45 **Dry weight/plant at 30 days as influenced by various treatments and their interaction (II year).**

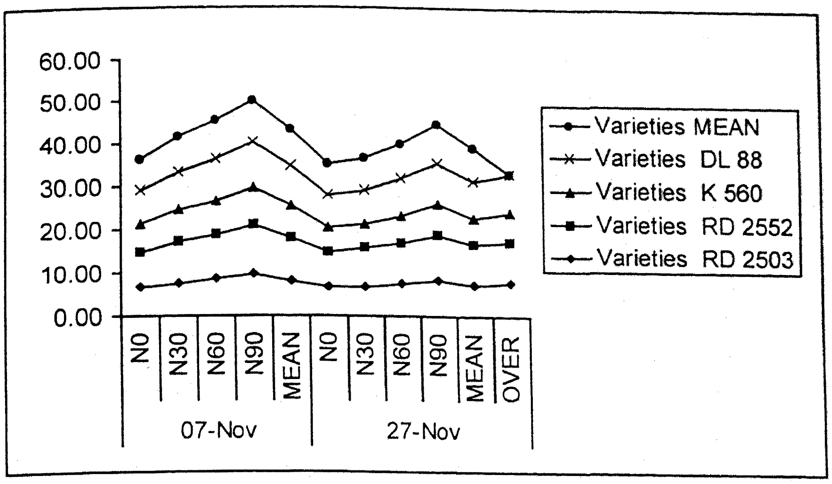
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	6.47	8.48	6.57	7.59	**7.28**
	N_{30}	7.44	9.82	7.58	8.38	**8.30**
	N_{60}	8.46	10.60	7.72	9.49	**9.07**
	N_{90}	9.60	11.60	8.52	10.38	**10.02**
	MEAN	**7.99**	**10.12**	**7.60**	**8.96**	**8.67**
27-Nov	N_0	6.47	8.50	5.54	7.63	**7.03**
	N_{30}	6.62	9.44	5.41	7.83	**7.32**
	N_{60}	7.40	9.56	6.55	8.47	**7.99**
	N_{90}	8.36	10.69	6.98	9.56	**8.90**
	MEAN	**7.21**	**9.55**	**6.12**	**8.37**	**7.81**
OVER ALL MEAN		**7.60**	**9.83**	**6.86**	**8.66**	

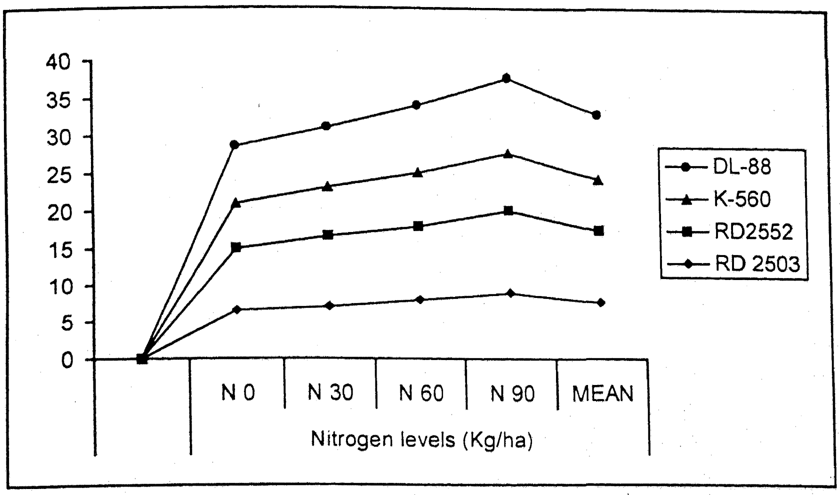
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	6.47	7.03	7.93	8.98	**7.60**
RD2552	8.49	9.63	10.08	11.14	**9.83**
K-560	6.05	6.49	7.13	7.75	**6.86**
DL-88	7.61	8.10	8.98	9.97	**8.66**

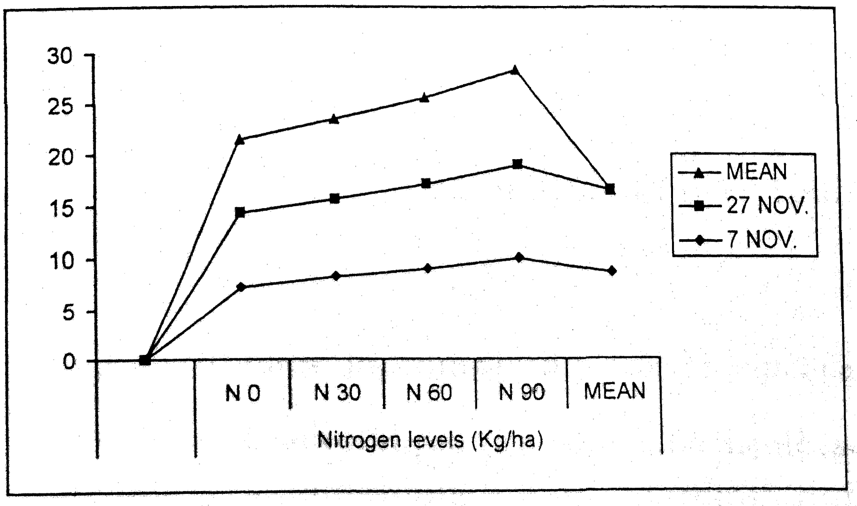
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	7.28	8.30	9.07	10.02	**8.67**
27 NOV.	7.03	7.32	7.99	8.90	**7.81**
MEAN	**7.15**	**7.81**	**8.53**	**9.46**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.15	0.07	0.14	0.11	0.22	0.15	0.15
C.D. 5%	0.37	0.17	0,33	0,22	N.S.	0.31	N.S.

Graph-4.45 **Dry weight/plant at 30 days as influenced by various treatments and their inateraction (II year)**







recorded significantly higher dry weight (6.78 and 9.83 g in respective years) over rest of the varieties. The second best was DL 88 and the lowest value was recorded in case of K560 (4.45 and 6.86 g in respective years). Late sowing by 20 days decreased the dry weight significantly. However, increasing levels of nitrogen increased this parameter significantly. Accordingly maximum dry weight (6.77 and 9.46 g) was recorded in case of N_{90}. Amongst the treatment interactions, RD 2552 with normal sowing date and N_{90} resulted in significantly higher dry weight (8.95 and 11.60 g in both the years).

Similarly, RD 2552 with N_{90} and normal sowing date with N_{90} recorded the best results.

4.1.26 Dry weight/plant at 60 DAS :

The data in Table 4.46 and 4.47 indicate the similar ~~result~~ treands results in both the years. Multifold rise in dry weight was in general, recorded between 30 and 60 days growth interval. RD 2552 recorded significantly higher dry weight (36.80 and 38.57 g in both the years) over other varieties. This was followed by DL 88 and then RD 2503. The variety K 560 gave the poor performance (21.10 and 25.72 g /dry weight plant in both the years).

Late sowing by 20 days discouraged dry weight significantly whereas increasing N-levels encouraged this parameter significantly.

Table 4.46 **Dry weight/plant at 60 days as influenced by various treatments and their interaction (I year).**

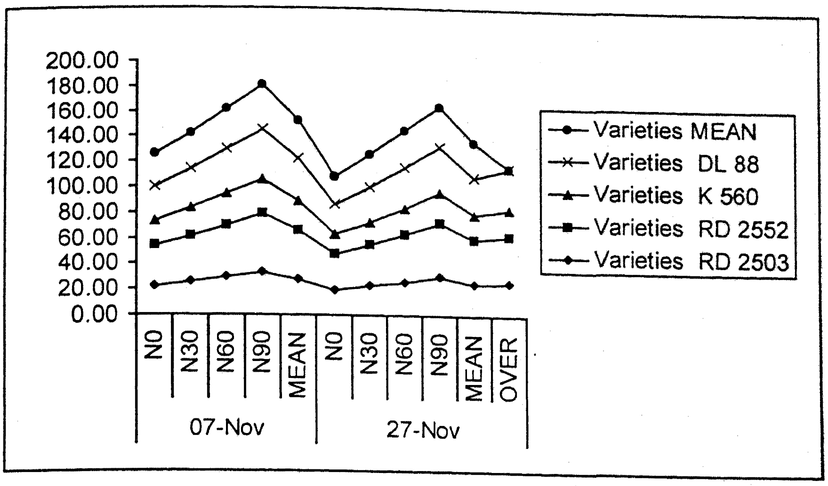
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	22.45	32.08	18.93	26.73	**25.05**
	N_{30}	25.56	35.86	21.83	30.29	**28.38**
	N_{60}	29.03	40.54	24.79	34.93	**32.32**
	N_{90}	32.65	45.95	26.52	39.82	**36.23**
	MEAN	**27.42**	**38.61**	**23.02**	**32.94**	**30.50**
27-Nov	N_0	19.30	28.43	15.49	23.07	**21.57**
	N_{30}	22.96	31.79	17.72	27.83	**25.07**
	N_{60}	26.04	37.43	20.15	32.11	**28.93**
	N_{90}	30.33	42.36	23.39	35.66	**32.58**
	MEAN	**24.66**	**35.00**	**19.19**	**29.67**	**27.13**
OVER ALL MEAN		**26.04**	**36.80**	**21.10**	**31.30**	

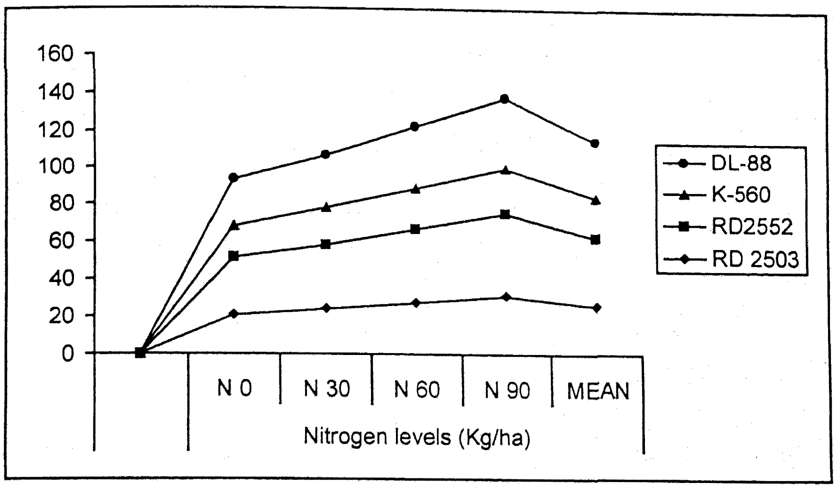
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	20.87	24.26	27.53	31.49	**26.04**
RD2552	30.25	33.82	38.98	44.15	**36.80**
K-560	17.21	19.77	22.47	24.35	**21.10**
DL-88	24.90	29.06	33.52	37.74	**31.30**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	25.05	28.38	32.32	36.23	**30.50**
27 NOV.	21.57	25.07	28.93	32.58	**27.13**
MEAN	**23.31**	**26.72**	**30.62**	**34.40**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.87	1.08	2.15	1.28	2.57	2.81	1.90
C.D. 5%	2.13	2.48	N.S.	2.58	5.16	N.S.	N.S.

Graph-4.46 **Dry weight/plant at 60 days as influenced by various treatments and their inateraction (I year)**





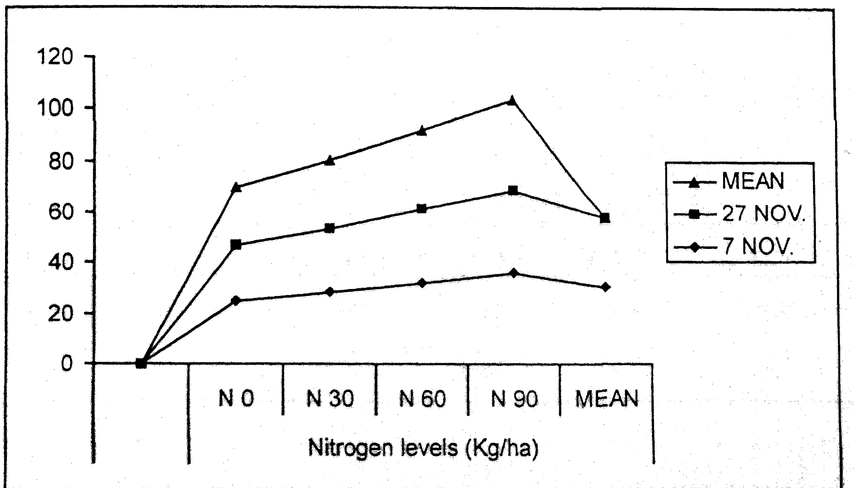


Table 4.47 Dry weight/plant at 60 days as influenced by various treatments and their interaction (II year).

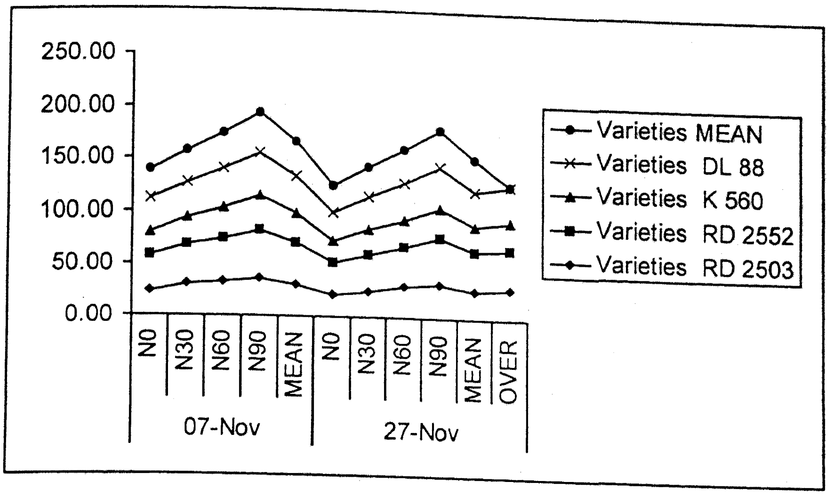
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	24.24	34.16	22.30	30.38	**27.77**
	N_{30}	31.23	37.08	25.49	32.18	**31.50**
	N_{60}	33.38	41.39	28.66	36.31	**34.93**
	N_{90}	36.41	46.46	31.51	40.72	**38.77**
	MEAN	**31.31**	**39.77**	**26.99**	**34.90**	**33.24**
27-Nov	N_0	21.38	31.69	20.49	26.43	**25.00**
	N_{30}	25.50	35.35	23.52	30.49	**28.71**
	N_{60}	30.39	38.25	25.43	34.35	**32.10**
	N_{90}	33.25	44.23	28.38	38.30	**36.04**
	MEAN	**27.63**	**37.38**	**24.45**	**32.39**	**30.46**
	OVER ALL MEAN	**29.47**	**38.57**	**25.72**	**33.64**	

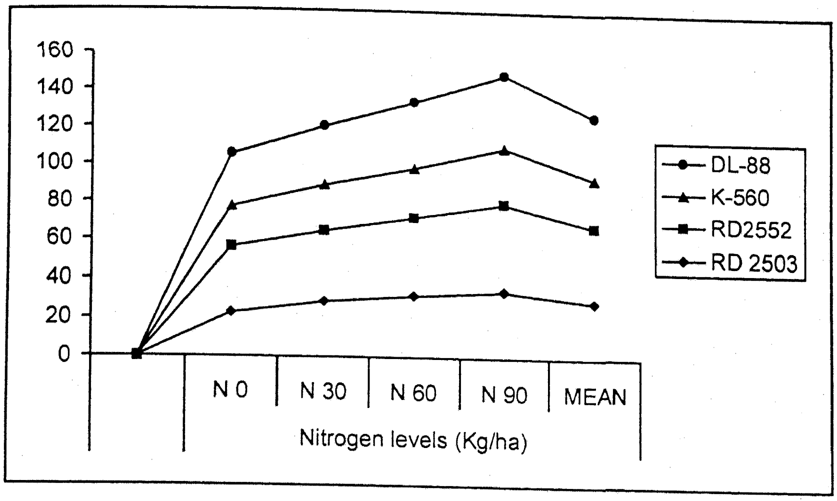
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	22.81	28.36	31.88	34.83	**29.47**
RD2552	32.92	36.21	39.82	45.34	**38.57**
K-560	21.39	24.50	27.04	29.94	**25.72**
DL-88	28.40	31.33	35.33	39.51	**33.64**

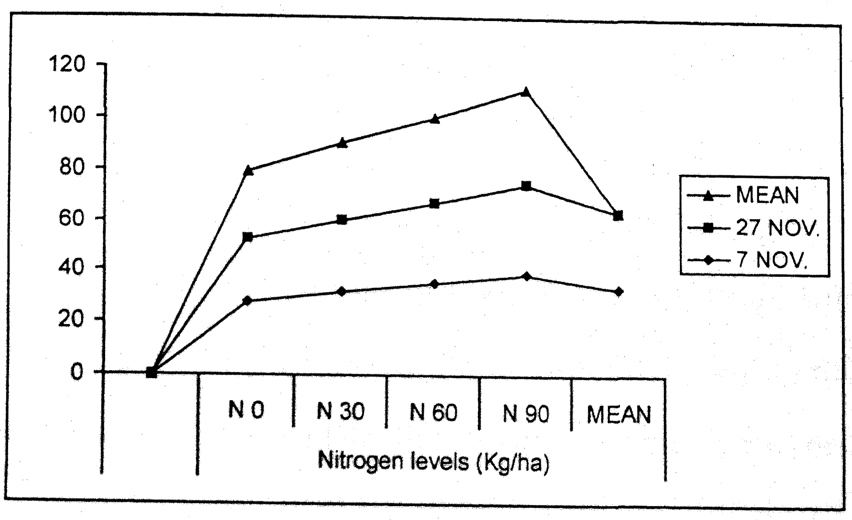
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	27.77	31.50	34.93	38.77	**33.24**
27 NOV.	25.00	28.71	32.10	36.04	**30.46**
MEAN	**26.38**	**30.10**	**33.51**	**37.40**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em(±) ±	0.99	0.75	1.50	1.11	2.22	1.57	1.55
C.D. 5%	2.43	1.72	N.S.	2.24	N.S.	N.S.	N.S.

Graph-4.47 **Dry weight/plant at 60 days as influenced by various treatments and their inateraction (II year)**







Thus at N_{90}, the maximum dry weight was 34.40 g in first year and 37.40 g in second year. Only nitrogen x variety interaction was found significant in first year and the remaining interactions were non significant in both the years. Accordingly, RD 2552 with N_{90} gave significantly higher dry weight (44.15 g/plant in first year only) over all the rest of the interactions. Similar trend was obtained in second year also but non-significant.

4.1.27 Dry weight/plant at 90 DAS :

The ~~result~~ trend of results was the same as observed at 60 days stage of crop growth (Table 4.48 and 4.49). The maximum dry weight (130.42 and 138.97 g) was recorded in case of RD 2552, being significantly superior to rest of the varieties. The second best variety was DL 88 (110.80 to 117.99 g dry weight). This was followed by RD 2503. The minimum dry weight (61.91 and 70.02 g) was recorded in case of K-560.

Late sowing adversely affected upon this parameter, the dry weight was significantly reduced. Increasing levels of nitrogen increased the dry weight significantly. Accordingly, N_{90} level resulted in maximum dry weight (115.70 and 124.70 g /plant in both the years). On the other hand, the minimum dry weight (80.14 and 87.67 g) was recorded in case of control (No). Amongst the interactions, varieties x sowing dates proved to be significant in both the years. As such, RD 2552 with normal date resulted

Table 4.48 **Dry weight/plant at 90 days as influenced by various treatments and their interaction (I year).**

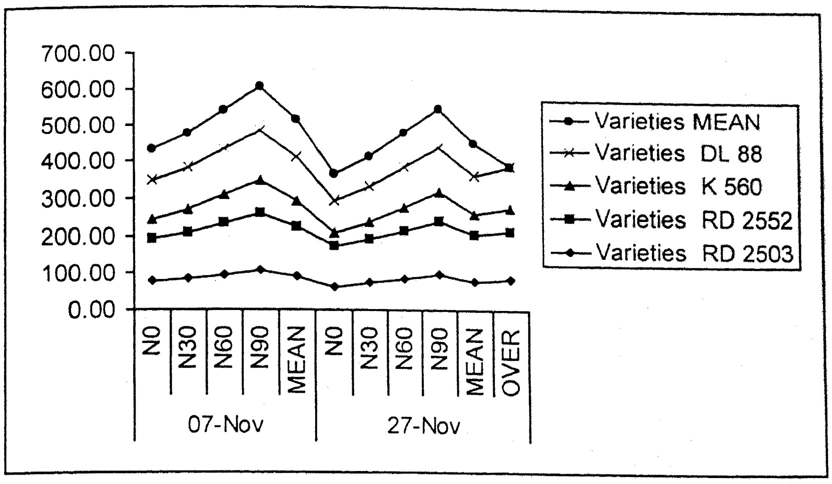
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	77.30	115.47	52.37	102.63	**86.94**
	N_{30}	82.53	125.50	61.17	112.30	**95.37**
	N_{60}	94.23	140.17	75.33	124.26	**108.50**
	N_{90}	105.33	153.33	89.30	138.17	**121.53**
	MEAN	**89.85**	**133.62**	**69.54**	**119.34**	**103.09**
27-Nov	N_0	62.60	110.23	34.33	86.20	**73.34**
	N_{30}	73.27	118.17	46.40	93.27	**82.78**
	N_{60}	83.27	133.37	60.23	108.43	**96.32**
	N_{90}	95.00	147.13	76.20	121.20	**109.88**
	MEAN	**78.53**	**127.23**	**54.29**	**102.27**	**90.58**
OVER ALL MEAN		**84.19**	**130.42**	**61.91**	**110.80**	

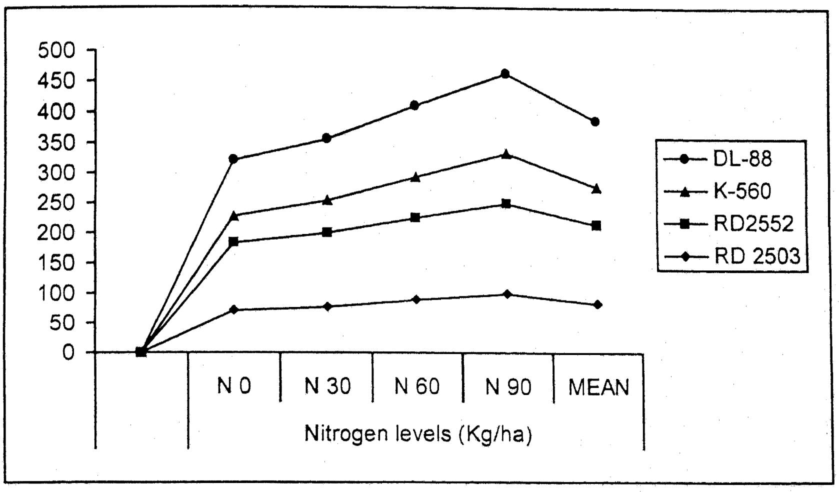
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	69.95	77.90	88.75	100.18	**84.19**
RD2552	112.85	121.83	136.77	150.23	**130.42**
K-560	43.35	53.78	67.78	82.75	**61.91**
DL-88	94.91	102.78	116.34	129.68	**110.80**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	86.94	95.37	108.50	121.53	**103.09**
27 NOV.	73.34	82.78	96.32	109.88	**90.58**
MEAN	**80.14**	**89.10**	**102.41**	**115.70**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.23	0.19	0.39	0.36	0.73	0.51	0.49
C.D. 5%	0.56	0.45	0.90	0.73	1.46	N.S.	1.00

Graph-4.48 **Dry weight/plant at 90 days as influenced by various treatments and their inateraction (I year)**





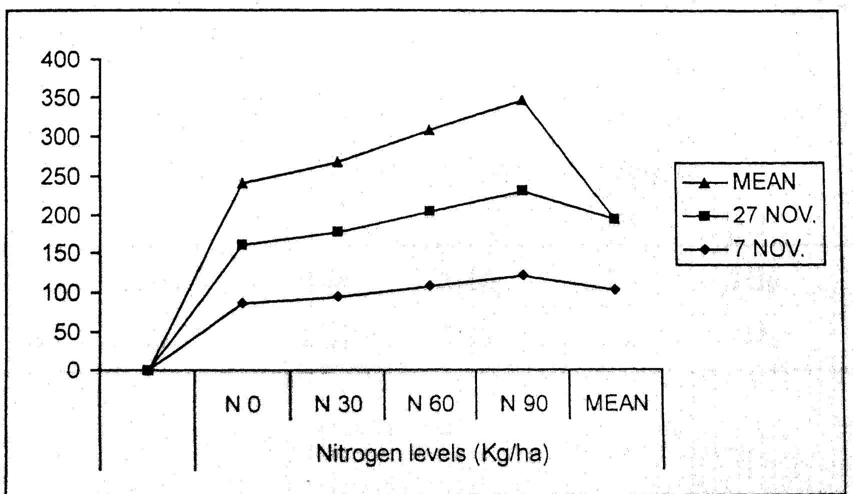


Table 4.49 Dry weight/plant at 90 days as influenced by various treatments and their interaction (II year).

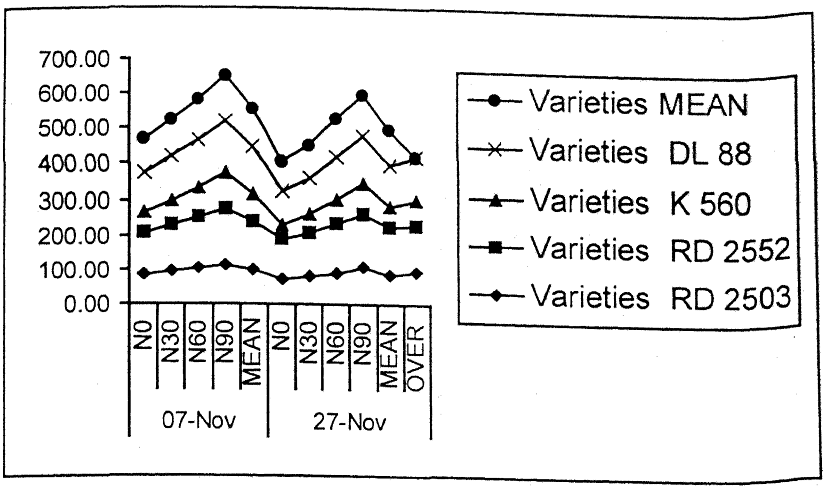
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	85.46	122.58	59.53	108.27	**93.96**
	N_{30}	93.70	135.52	68.38	120.24	**104.46**
	N_{60}	103.21	148.18	83.17	130.20	**116.19**
	N_{90}	112.69	162.42	98.23	147.75	**130.27**
	MEAN	**98.76**	**142.17**	**77.33**	**126.61**	**111.22**
27-Nov	N_0	72.28	117.83	42.37	93.09	**81.39**
	N_{30}	81.11	126.14	53.64	99.43	**90.08**
	N_{60}	92.30	142.75	69.44	116.46	**105.24**
	N_{90}	106.26	156.38	85.39	128.53	**119.14**
	MEAN	87.99	135.77	62.71	109.38	98.96
OVER ALL MEAN		**93.37**	**138.97**	**70.02**	**117.99**	

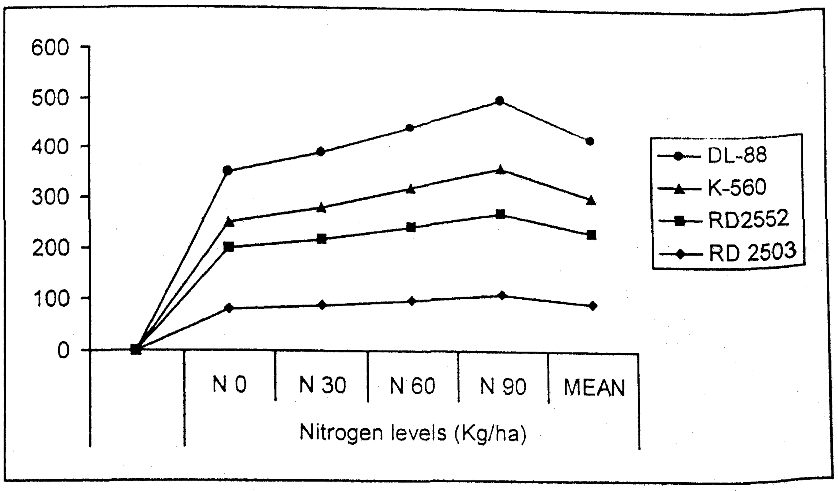
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	78.87	87.40	97.75	109.47	**93.37**
RD2552	120.20	130.83	145.46	159.40	**138.97**
K-560	50.95	61.01	76.30	91.81	**70.02**
DL-88	100.68	109.83	123.33	138.14	**117.99**

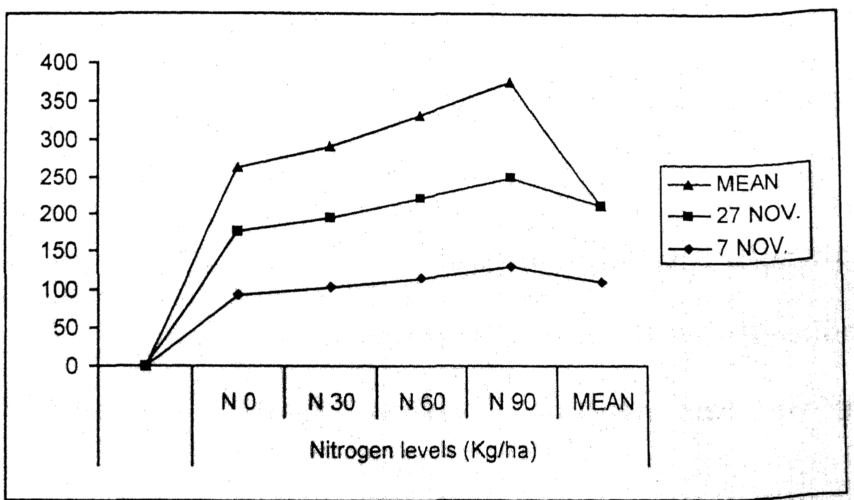
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	93.96	104.46	116.19	130.27	**111.22**
27 NOV.	81.39	90.08	105.24	119.14	**98.96**
MEAN	**87.67**	**97.27**	**110.71**	**124.70**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.50	0.33	0.66	1.10	2.20	1.56	1.39
C.D. 5%	1.23	0.76	1.52	2.21	N.S.	N.S.	N.S.

Graph-4.49 Dry weight/plant at 90 days as influenced by various treatments and their inateraction (II year)







in significantly higher dry weight (133.62 and 142.17 g) over rest of the interactions. When N_{90} was combined with both these treatments, the dry weight was further enhanced (153.33 g in first year and 162.42 g in second year).

4.1.28 Dry weight/plant at harvest :

The data in Table 4.50 and 4.51 indicate similar trend as observed in case of earlier stages. However, at this stage, all the treatment interactions were found to be significant in both the years. RD 2552 recorded significantly higher dry weight (177.59 and 186.68 g) over rest of the varieties. This was followed by DL 88 and then RD 2503. The lowest dry weight (90.31 and 98.87 g) was noted in case of K 560 variety. Late sowing by 20 days (27 November) significantly reduced the dry weight as compared to the normal sown crop (7 November), the decline was from 146.37 g to 132.15 g in first year, and 156.38 g to 141.24 g in second year. The maximum N level (N_{90}) recorded the maximum dry weight (164.94 and 175.70 g in both the years), whereas minimum values was 111.34 and 117.98 g in case of N_0 levle. The variety RD 2552 sown at the normal date (7 November) with N_{90} further augmented the dry weight i.e. 217.31 g in first year and 224.42 in second year. This combination was significantly superior to all the rest of the treatment combinations. Similar was the case with variety x dates, variety x nitrogen and nitrogen x

Table 4.50 Dry weight/plant at harvesting as influenced by various treatments and their interaction (I year).

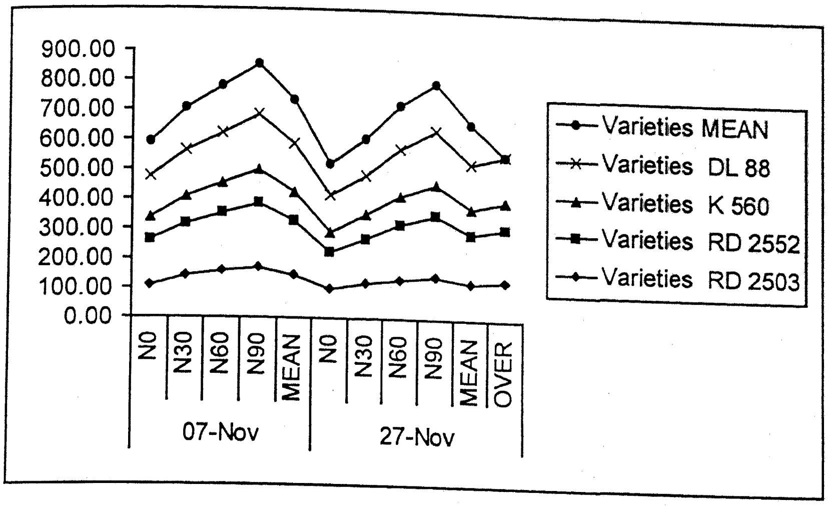
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	110.38	151.25	75.29	136.18	**118.27**
	N_{30}	140.45	178.28	88.31	155.32	**140.59**
	N_{60}	156.36	198.32	100.37	167.27	**155.58**
	N_{90}	172.20	217.31	112.31	182.30	**171.03**
	MEAN	**144.85**	**186.29**	**94.07**	**160.27**	**146.37**
27-Nov	N_0	98.39	126.27	66.46	126.56	**104.42**
	N_{30}	120.35	152.28	80.20	132.33	**121.29**
	N_{60}	132.20	190.38	95.23	158.30	**144.03**
	N_{90}	146.26	206.46	104.30	178.42	**158.86**
	MEAN	**124.30**	**168.85**	**86.55**	**148.90**	**132.15**
	OVER ALL MEAN	**134.57**	**177.59**	**90.31**	**154.58**	

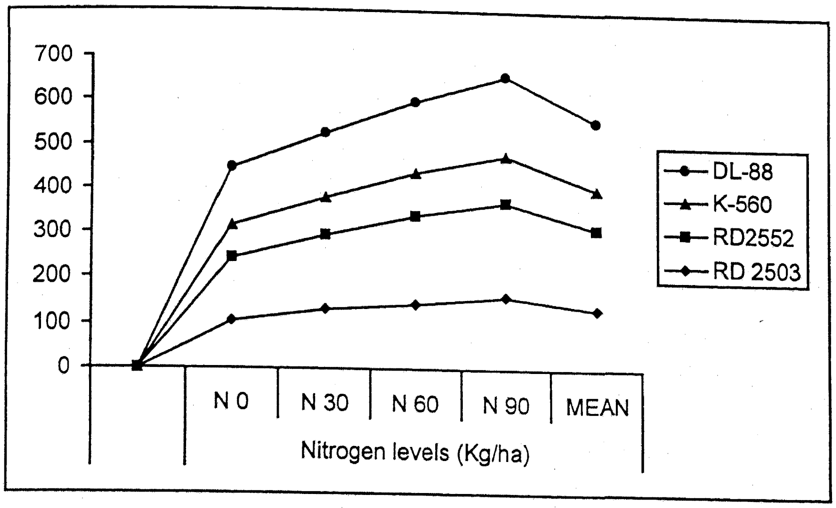
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	104.38	130.40	144.28	159.23	**134.57**
RD2552	138.76	165.28	194.35	211.88	**177.59**
K-560	70.87	84.25	97.80	108.30	**90.31**
DL-88	131.37	143.82	162.78	180.36	**154.58**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	118.27	140.59	155.58	171.03	**146.37**
27 NOV.	104.42	121.29	144.03	158.86	**132.15**
MEAN	**111.34**	**130.94**	**149.80**	**164.94**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	0.41	0.32	0.64	0.55	1.10	0.78	0.75
C.D. 5%	1.00	0.73	1.47	1.11	2.22	1.57	1.54

Graph-4.50 Dry weight/plant at harvesting as influenced by various treatments and their inateraction (I year)





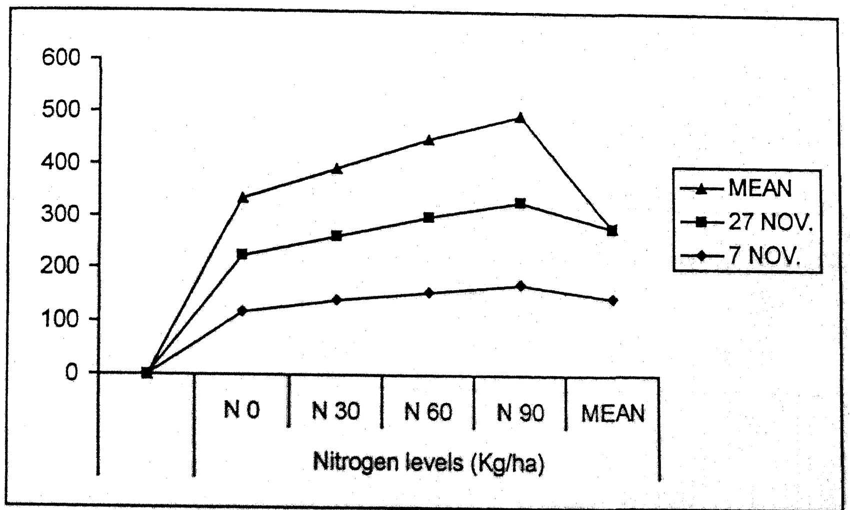


Table 4.51 **Dry weight/plant at harvesting as influenced by various treatments and their interaction (II year).**

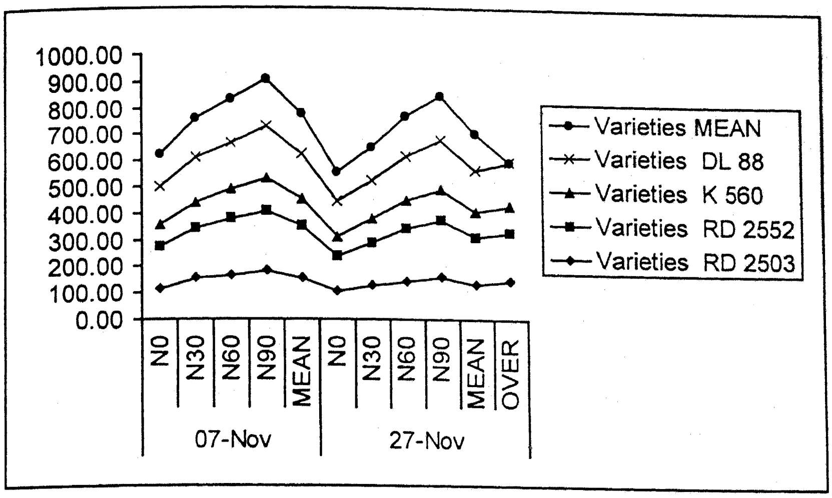
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	116.25	158.32	81.19	143.69	**124.86**
	N_{30}	158.20	188.12	96.33	165.30	**151.99**
	N_{60}	167.43	212.28	109.24	178.31	**166.81**
	N_{90}	185.70	224.42	122.09	195.26	**181.87**
	MEAN	**156.89**	**195.78**	**102.21**	**170.64**	**156.38**
27-Nov	N_0	105.66	133.29	73.37	132.13	**111.11**
	N_{30}	129.44	161.31	89.14	141.24	**130.28**
	N_{60}	142.52	199.53	105.32	168.69	**154.01**
	N_{90}	159.22	216.22	114.31	188.42	**169.54**
	MEAN	**134.21**	**177.59**	**95.53**	**157.62**	**141.24**
OVER ALL MEAN		**145.55**	**186.68**	**98.87**	**164.13**	

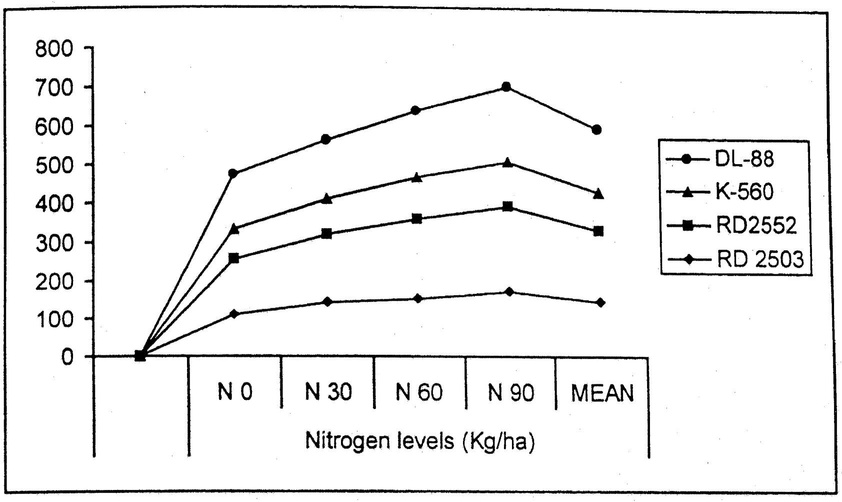
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	110.95	143.82	154.97	172.46	**145.55**
RD2552	145.80	174.71	205.90	220.32	**186.68**
K-560	77.28	92.73	107.28	118.20	**98.87**
DL-88	137.91	153.27	173.50	191.84	**164.13**

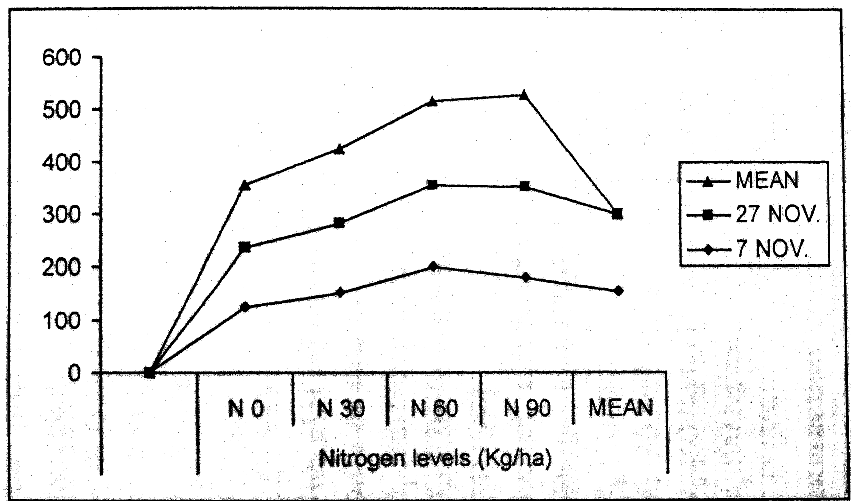
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	124.86	151.99	199.81	181.87	**156.38**
27 NOV.	111.11	130.28	154.01	169.54	**141.24**
MEAN	**117.98**	**141.13**	**160.41**	**175.70**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. +	1.45	0.68	1.37	1.45	2.91	2.05	1.91
C.D. 5%	3.55	1.58	3.16	2.92	5.84	4.13	3.91

Graph-4.51 **Dry weight/plant at harvesting as influenced by various treatments and their inateraction (II year)**







Summary table -4.52

Dry weight/plant at different growth ~~intervals~~ stages

Treatments	Dry weight/plant (gm)											
Main plot treatments	30 Days			60 Days			90 Days			Maturity		
Varieties	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean	I Year	II Year	Mean
V_1-(R.D.2503)	04.90	07.60	**06.25**	26.04	29.47	**27.75**	84.19	93.37	**88.78**	134.57	145.55	**140.06**
V_2-(R.D.2552)	06.78	09.83	**08.30**	36.80	28.57	**32.68**	130.42	138.97	**134.69**	177.59	186.68	**182.13**
V_3-(K.560)	04.45	06.86	**05.65**	21.10	25.72	**23.41**	61.91	70.02	**65.96**	90.31	98.87	**94.59**
V_4-(DL.88)	05.93	08.66	**07.29**	31.30	33.64	**32.47**	110.80	117.99	**114.39**	154.58	164.13	**159.35**
C.D.(5%)	00.02	00.37	**00.19**	02.13	02.43	**02.28**	00.56	01.23	**00.89**	01.00	03.55	**02.27**
Sub plot treatments												
Date of sowing												
D_1-(7th November)	05.82	08.67	**07.24**	30.50	33.24	**31.87**	103.09	111.22	**107.15**	146.37	156.38	**151.37**
D_2-(27th November)	05.20	07.81	**06.50**	27.13	30.46	**28.79**	90.58	98.96	**94.77**	132.15	141.24	**136.69**
C.D.(5%)	00.02	00.17	**00.09**	02.48	01.73	**02.10**	00.45	00.76	**00.60**	00.73	01.58	**01.15**
Sub sub plot treatments												
Nitrogen levels (Kg/ha.)												
N_1-(Control)	04.58	07.15	**05.86**	23.31	26.38	**24.84**	80.14	87.67	**83.90**	111.34	117.98	**114.66**
N_2-(30 Kg/ha.)	04.84	07.81	**06.32**	26.70	30.10	**28.40**	89.10	97.27	**93.18**	130.94	141.13	**136.03**
N_3-(60 Kg/ha.)	05.85	08.53	**07.19**	30.62	33.51	**32.06**	102.41	110.71	**106.56**	149.80	160.41	**155.10**
N_4-(90 Kg/ha.)	06.77	09.46	**08.11**	34.40	37.40	**35.90**	115.70	124.70	**120.20**	164.94	175.70	**170.32**
C.D.(5%)	00.02	00.22	**00.12**	02.58	02.24	**02.41**	00.73	02.21	**01.47**	01.11	02.92	**02.01**
Interaction												
VxD	00.04	00.33		N.S.	N.S.		00.90	01.52		01.47	03.16	
VxN	00.04	N.S.		N.S.	N.S.		01.46	N.S.		02.22	05.84	
DxN	00.03	00.31		N.S.	N.S.		N.S.	N.S.		01.57	04.13	
VxDxN	00.03	N.S.		N.S.	N.S.		01.00	N.S.		01.54	03.91	

dates combinations. In every case RD 2552 with normal dates or N_{90} levels proved the best.

4.1.29 Dry weight/plant at different growth intervals:

The average dry weight/plant was found to increase by multifold with the advancement of growth stage only upto 90 days (Summary Table 4.52). The variety RD 2552 taken a drastic lead in this respect which is apparent at 90 days and maturity stages. Abrupt rise was noted. This was followed by DL 88, RD 2503 and then K 560. At 30 days stage it ranged from 5.65 to 8.30 g which went upto 94.59 to 182.13 g at maturity stage. At every stage, RD 2552 recorded maximum dry weight. The minimum dry weight was obtained in case of K 560 at every stage. Late sowing drastically reduced this parameter at every stage as compared to normal sowing. Increasing N-levels upto N_{90} increased this parameter significantly at every stage of crop growth.

4.2 Yield attributes :

4.2.1 No. of spikelets/plant :

Whether it is spikelets per plant or spikes per plant ?

The results in Table 4.53 and 4.54 reveal that the number of spikelets/plant was influenced significantly due to the separate effect of treatments but not due to treatment interactions. This was the situation in both the years. RD 2552 recorded significantly higher spikelets (6.12 and 6.46/plant) as compared to rest of the

Table 4.53 No. of spikelets/plant as influenced by various treatments and their interaction (I year).

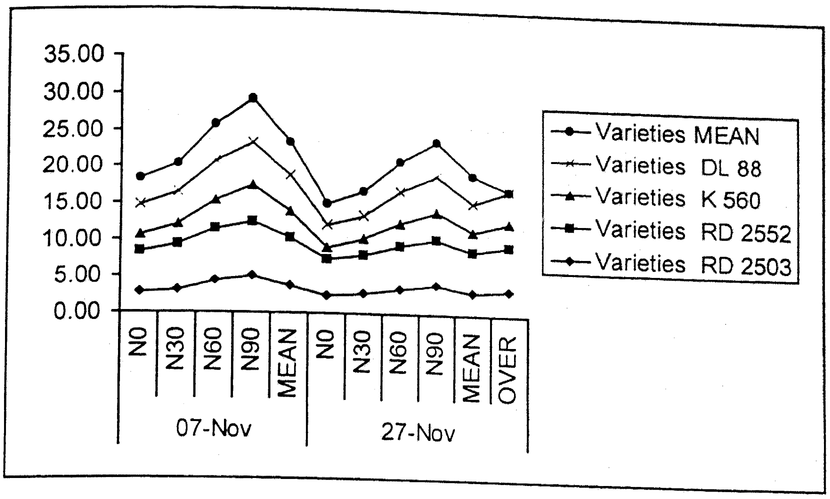
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	2.67	5.67	2.33	4.00	**3.67**
	N_{30}	3.00	6.33	2.67	4.33	**4.08**
	N_{60}	4.33	7.00	4.00	5.33	**5.16**
	N_{90}	5.00	7.33	5.00	6.00	**5.83**
	MEAN	**3.75**	**6.58**	**3.50**	**4.91**	**4.68**
27-Nov	N_0	2.33	5.00	1.67	3.00	**3.00**
	N_{30}	2.67	5.33	2.33	3.00	**3.33**
	N_{60}	3.33	6.00	3.00	4.33	**4.16**
	N_{90}	4.00	6.33	3.67	5.00	**4.75**
	MEAN	3.08	5.66	2.67	3.83	3.81
OVER ALL MEAN		3.42	6.12	3.08	4.37	

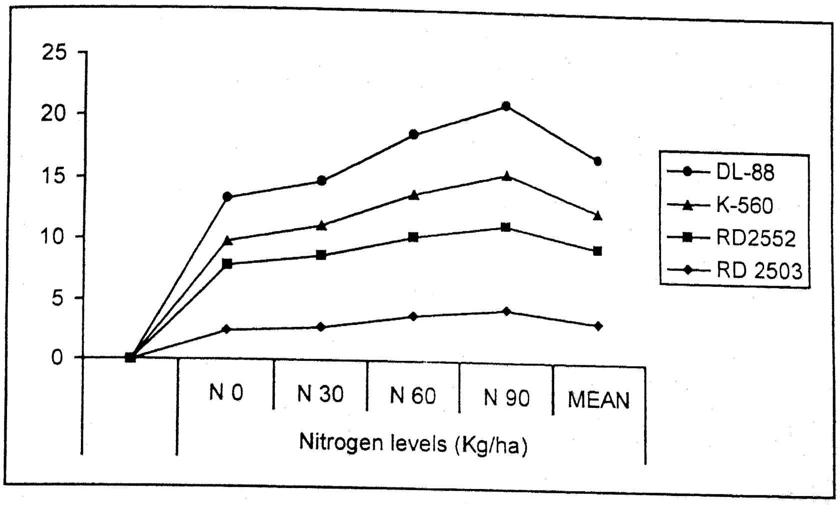
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	2.50	2.83	3.83	4.50	**3.42**
RD2552	5.33	5.83	6.50	6.83	**6.12**
K-560	2.00	2.50	3.50	4.33	**3.08**
DL-88	3.50	3.66	4.83	5.50	**4.37**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	3.67	4.08	5.16	5.83	**4.68**
27 NOV.	3.00	3.33	4.16	4.75	**3.81**
MEAN	**3.33**	**3.71**	**4.66**	**5.29**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	0.12	0.18	0.35	0.25	0.51	0.36	0.36
C.D. 5%	0.30	0.41	N.S.	0.51	N.S.	N.S.	N.S.

Graph-4.53 No. of spikelets/plant as influenced by various treatments and their inateraction (I year)





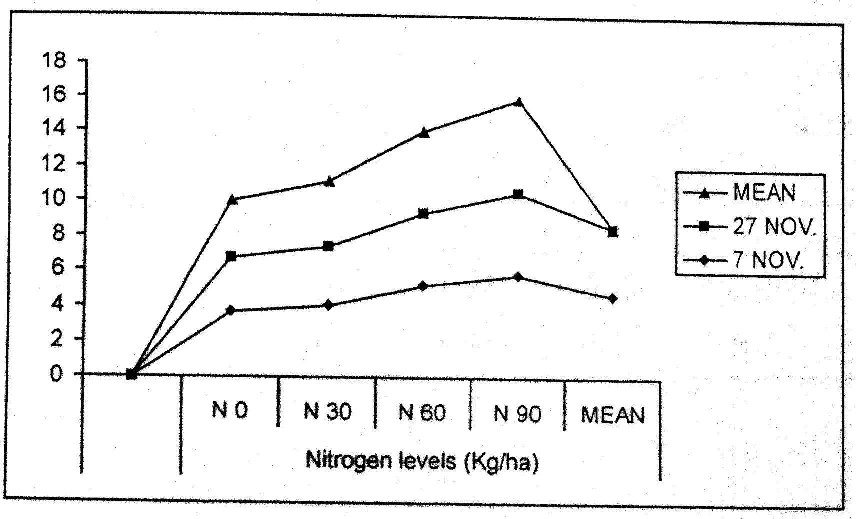


Table 4.54 No. of spikeletes/plant as influenced by various treatments and their interaction (II year).

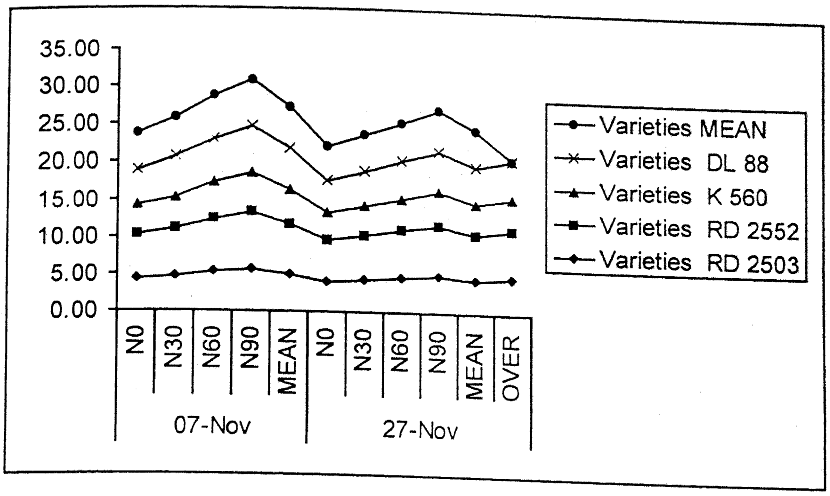
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	4.33	6.00	4.00	4.67	**4.75**
	N_{30}	4.67	6.33	4.33	5.33	**5.16**
	N_{60}	5.33	7.00	5.00	5.67	**5.75**
	N_{90}	5.67	7.67	5.33	6.00	**6.17**
	MEAN	**5.00**	**6.75**	**4.66**	**5.42**	**5.46**
27-Nov	N_0	4.00	5.67	3.67	4.33	**4.42**
	N_{30}	4.33	6.00	4.00	4.67	**4.75**
	N_{60}	4.67	6.33	4.33	5.00	**5.08**
	N_{90}	5.00	6.67	4.67	5.33	**5.42**
	MEAN	**4.50**	**6.17**	**4.17**	**4.83**	**4.92**
OVER ALL MEAN		**4.75**	**6.46**	**4.41**	**5.13**	

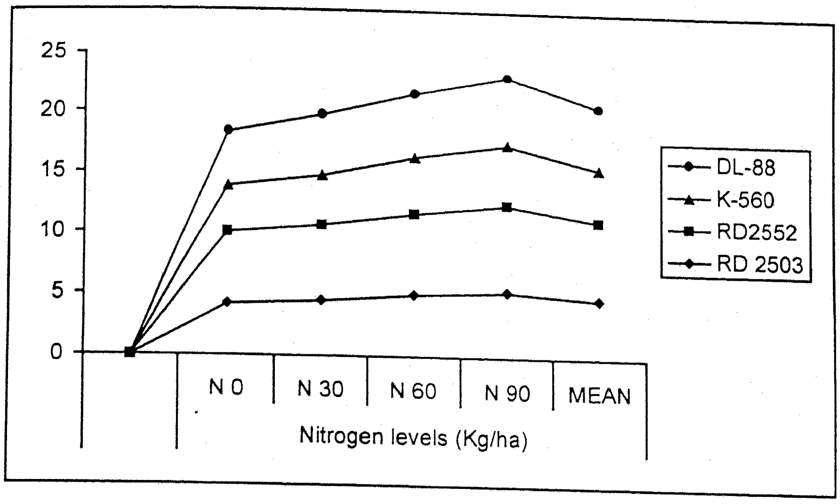
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	4.16	4.50	5.00	5.34	**4.75**
RD2552	5.83	6.17	6.67	7.17	**6.46**
K-560	3.83	4.15	4.67	5.00	**4.41**
DL-88	4.50	5.00	5.34	5.67	**5.13**

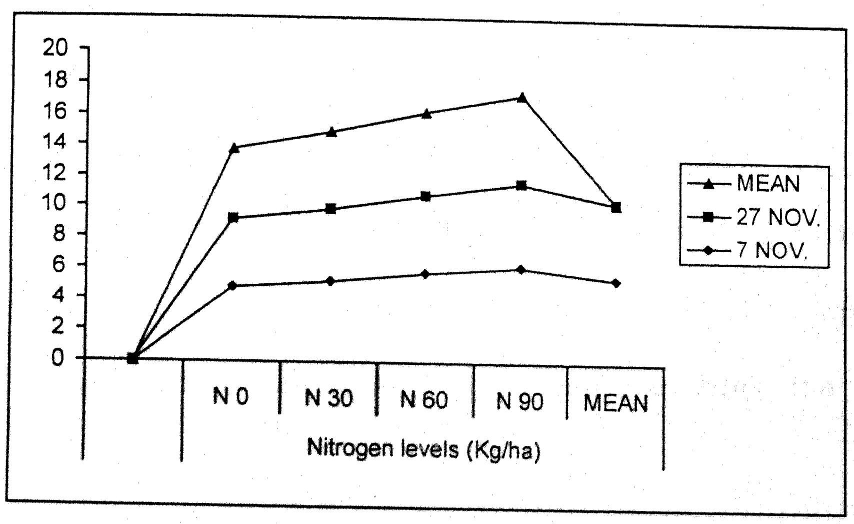
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	4.75	5.16	5.75	6.17	**5.46**
27 NOV.	4.42	4.75	5.08	5.42	**4.92**
MEAN	**4.59**	**4.96**	**5.42**	**5.79**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.14	0.14	0.28	0.22	0.45	0.32	0.31
C.D. 5%	0.34	0.32	N.S.	0.45	N.S.	N.S.	N.S.

Graph-4.54 No. of ~~spikelets/plant~~ as influenced by various treatments and their inateraction (II year)







varieties. This was followed by DL 88, RD 2503 and then K 560 . The spikelets in late sown crop were significantly reduced, whereas increasing levels of nitrogen encouraged this parameter almost significantly in both the years. Accordingly the highest spikelet number was 5.29/plant in first year and 5.79/plant in the second year at N_{90} nitrogen level. However the minimum spikelet number was 3.33 and 4.59/plant in case of no nitrogen (No).

4.2.2 Length of spike (cm) :

The length of spike was also measured and the mean data so obtained is being presented in Table 4.55 and 4.56. The separate effect of varietal, sowing date and N-level treatments exerted significant deviation in this yield component whereas there was no any significant change due to treatment interactions in both the years. Among the varieties, K 560 attained significantly higher spik-length (8.91 and 10.70 cm in both the years) as compared to rest of the varieties. This was, however, followed by RD 2552 (8.03 and 9.94 cm), and then DL 88 (7.07 and 8.12 cm). The minimum spike - length was recorded in case of RD 2503 (5.73 and 6.40 cm in both the years). The spike-length was also decreased due to late sowing by 20 days over normal sowing date. As such, it declined from 7.99 cm to 6.89 cm in first year, and 9.24 cm to 8.34 cm in second year. Increasing levels of nitrogen upto N_{90} increased this parameter significantly in both the years.

Table 4.55 No. of spike length (cm) as influenced by various treatments and their interaction (I year).

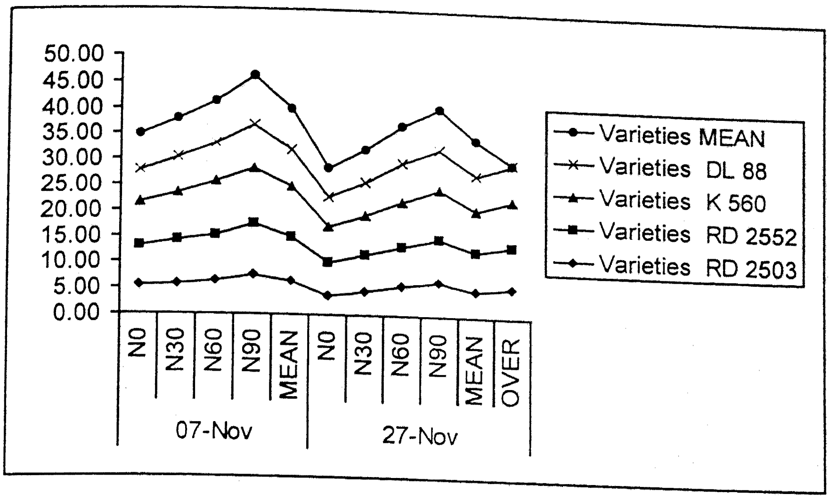
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	5.40	7.60	8.50	6.30	**6.95**
	N_{30}	5.80	8.40	9.30	6.70	**7.55**
	N_{60}	6.50	8.70	10.50	7.40	**8.27**
	N_{90}	7.60	9.80	10.80	8.60	**9.20**
	MEAN	**6.32**	**8.62**	**9.77**	**7.25**	**7.99**
27-Nov	N_0	3.70	6.50	6.70	5.80	**5.67**
	N_{30}	4.50	7.30	7.40	6.50	**6.42**
	N_{60}	5.80	7.60	8.60	7.50	**7.37**
	N_{90}	6.60	8.40	9.50	7.80	**8.07**
	MEAN	5.15	7.45	8.05	6.90	6.89
	OVER ALL MEAN	5.72	8.03	8.91	7.07	

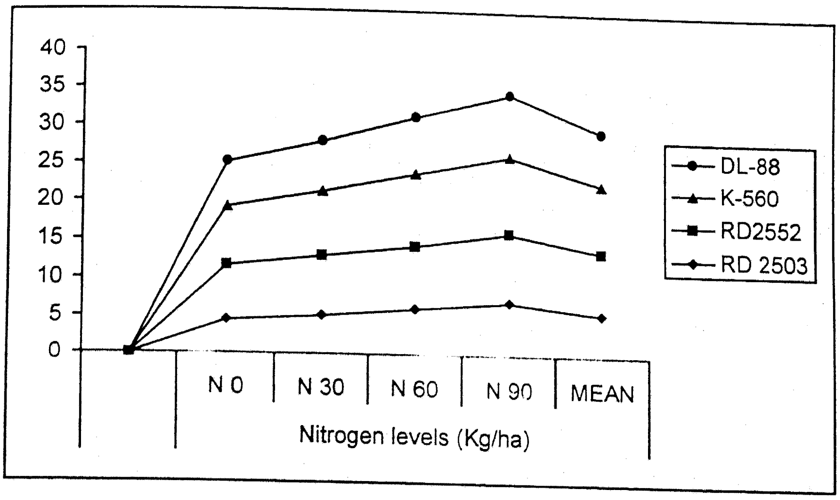
Varieties	Nitrogen levels (Kg/ha)				MEAN
	N_0	N_{30}	N_{60}	N_{90}	
RD 2503	4.55	5.15	6.15	7.10	**5.73**
RD2552	7.05	7.85	8.15	9.10	**8.03**
K-560	7.60	8.35	9.55	10.15	**8.91**
DL-88	6.05	6.60	7.45	8.20	**7.07**

Date of sowing	Nitrogen levels (Kg/ha)				MEAN
	N_0	N_{30}	N_{60}	N_{90}	
7 NOV.	6.95	7.55	8.27	9.20	**7.99**
27 NOV.	5.67	6.42	7.37	8.07	**6.89**
MEAN	**6.31**	**6.98**	**7.82**	**8.63**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.28	0.15	0.30	0.29	0.59	0.41	0.39
C.D. 5%	0.69	0.35	N.S.	0.59	N.S.	N.S.	N.S.

Graph-4.55 No. of spike length (cm) as influenced by various treatments and their inateraction (I year)





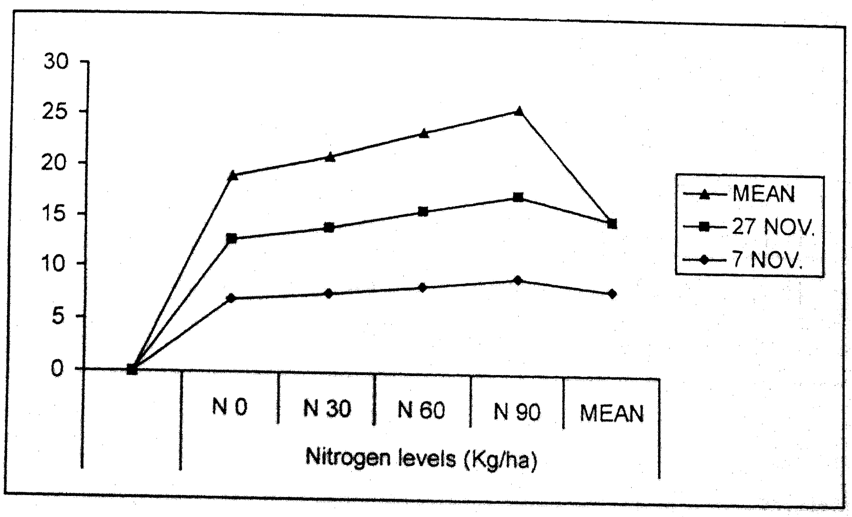


Table 4.56 No. of spike length (cm) as influenced by various treatments and their interaction (II year).

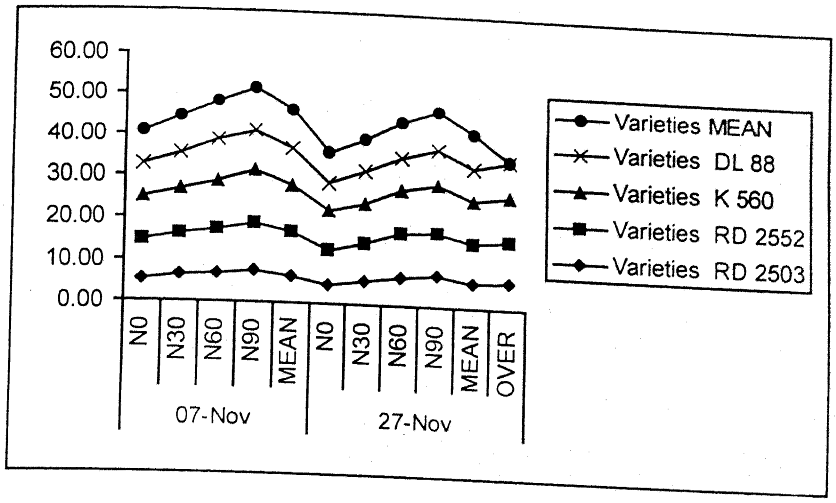
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	5.43	9.37	10.40	7.43	**8.16**
	N_{30}	6.50	9.80	10.80	8.33	**8.86**
	N_{60}	6.80	10.80	11.40	9.60	**9.65**
	N_{90}	7.70	11.40	12.27	9.80	**10.29**
	MEAN	**6.61**	**10.34**	**11.22**	**8.79**	**9.24**
27-Nov	N_0	4.67	8.30	9.30	6.60	**7.22**
	N_{30}	5.73	9.20	9.50	7.30	**7.93**
	N_{60}	6.83	10.50	10.50	7.47	**8.82**
	N_{90}	7.50	10.22	11.47	8.43	**9.40**
	MEAN	**6.18**	**9.55**	**10.19**	**7.45**	**8.34**
	OVER ALL MEAN	**6.40**	**9.94**	**10.70**	**8.12**	

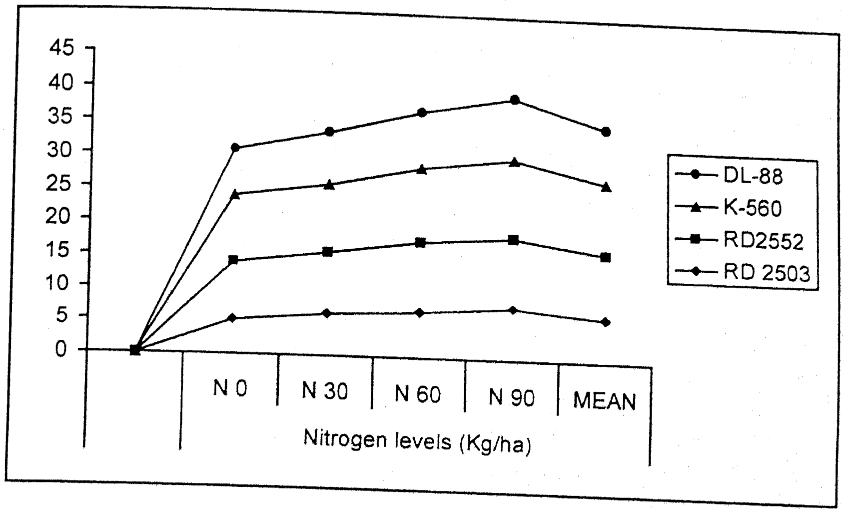
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	5.05	6.11	6.81	7.60	**6.40**
RD2552	8.83	9.50	10.65	10.81	**9.94**
K-560	9.85	10.15	10.95	11.87	**10.70**
DL-88	7.01	7.81	8.53	9.11	**8.12**

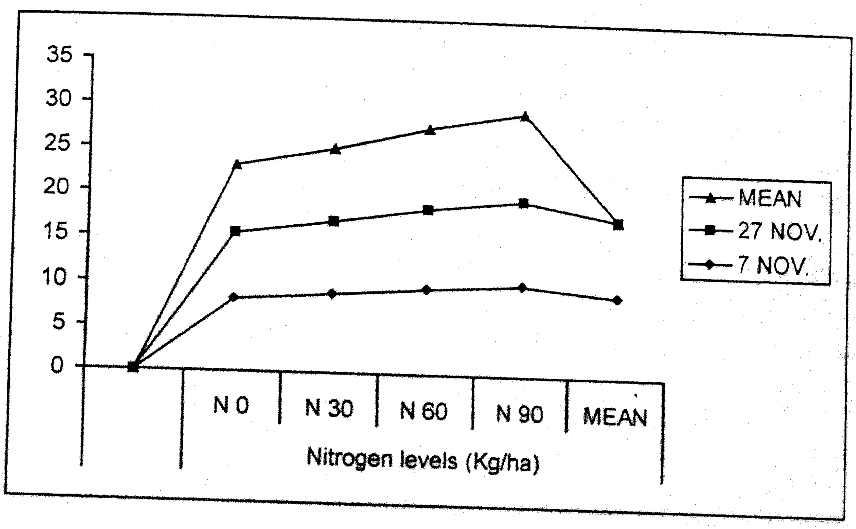
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	8.16	8.86	9.65	10.29	**9.24**
27 NOV.	7.22	7.93	8.82	9.40	**8.34**
MEAN	**7.69**	**8.39**	**9.23**	**9.84**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em.±	0.25	0.22	0.44	0.24	0.47	0.34	0.36
C.D. 5%	0.62	0.51	N.S.	0.48	N.S.	N.S.	N.S.

Graph-4.56 No. of spike length (cm) as influenced by various treatments and their inateraction (II year)







Thus, it enhanced from 6.31 cm at No to 8.63 cm at N_{90} in first year, and 7.69 cm at N_0 to 9.84 cm at N_{90} level of nitrogen in second year.

4.2.3 No. of spikelets/spike :

The spikelets/spike was also influenced significantly due to various treatments but not due to treatment interactions except in case of nitrogen x sowing date in first year (Tabel 4.57 and 4.58). The same variety K 560, which recorded maximum spike length, also gave the maximum number of spikelets/spike, being significantly superior to all the rest of the varieties (22.66 and 25.17 spikelets/spike in both the years). This was followed by RD 2552, DL 88 and then RD 2503. The spikelet number in case of RD 2503 was 16.24 in first year and 19.12/spike in second year.

Late sowing condition adversely affected the formation of spikelets/spike. It was decreased significantly round about by 4 spikelets/spike in both the years as compared to the normal sown conditions. Increasing levels of nitrogen encouraged this parameter significantly in both the years. The increase was upto the extent of 4 to 6 spikelets/spike due to highest N level (N_{90}) over no nitrogen (N_0) in both the years. Among the interactions, normal sowing date with N_{90} resulted in significantly higher spikelet number (23.66/spike), being significantly superior to all the remaining interactions. This was the situation in first year only, however,

Table 4.57 No. of spikeletes/spike as influenced by various treatments and their interaction (I year).

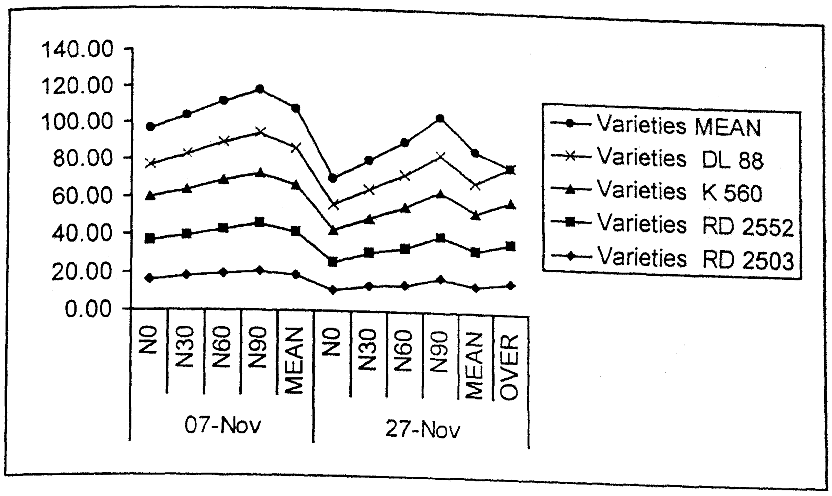
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	16.00	20.67	23.33	17.33	**19.33**
	N_{30}	18.00	21.00	24.67	19.33	**20.75**
	N_{60}	19.33	23.33	26.00	20.67	**22.33**
	N_{90}	20.33	25.00	27.33	22.00	**23.66**
	MEAN	**18.41**	**22.50**	**25.33**	**19.83**	**21.52**
27-Nov	N_0	11.00	15.00	16.67	13.33	**14.00**
	N_{30}	13.33	17.33	18.00	15.33	**16.00**
	N_{60}	14.33	19.33	21.33	17.33	**18.08**
	N_{90}	17.67	22.00	24.00	20.00	**20.92**
	MEAN	**14.08**	**18.41**	**20.00**	**16.50**	**17.25**
OVER ALL MEAN		**16.24**	**20.45**	**22.66**	**18.16**	

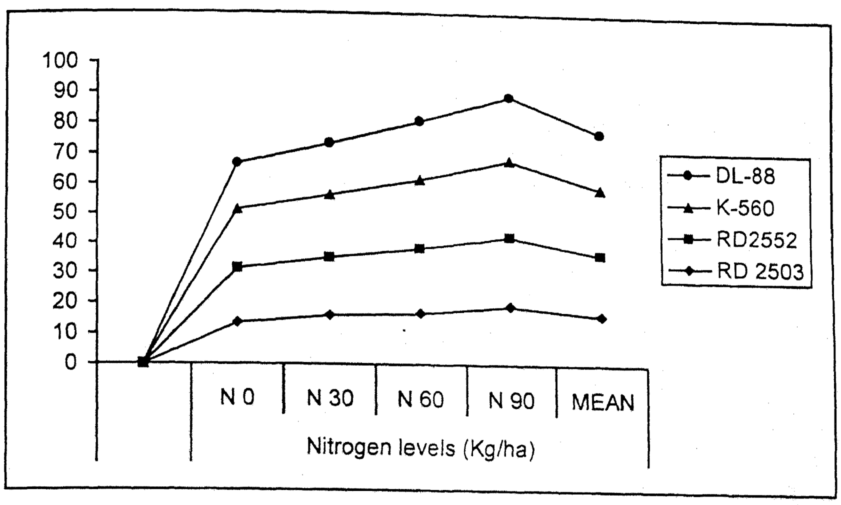
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	13.50	15.66	16.83	19.00	**16.24**
RD2552	17.83	19.16	21.33	23.50	**20.45**
K-560	20.00	21.33	23.66	25.66	**22.66**
DL-88	15.33	17.33	19.00	21.00	**18.16**

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	19.33	20.75	22.33	23.66	**21.52**
27 NOV.	14.00	16.00	18.08	20.92	**17.25**
MEAN	**16.66**	**18.37**	**20.20**	**22.29**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	0.34	0.20	0.41	0.35	0.70	0.49	0.47
C.D. 5%	0.83	0.47	N.S.	0.70	N.S.	0.99	N.S.

Graph-4.57 **No. of spikelets/spike as influenced by various treatments and their inateraction (I year)**





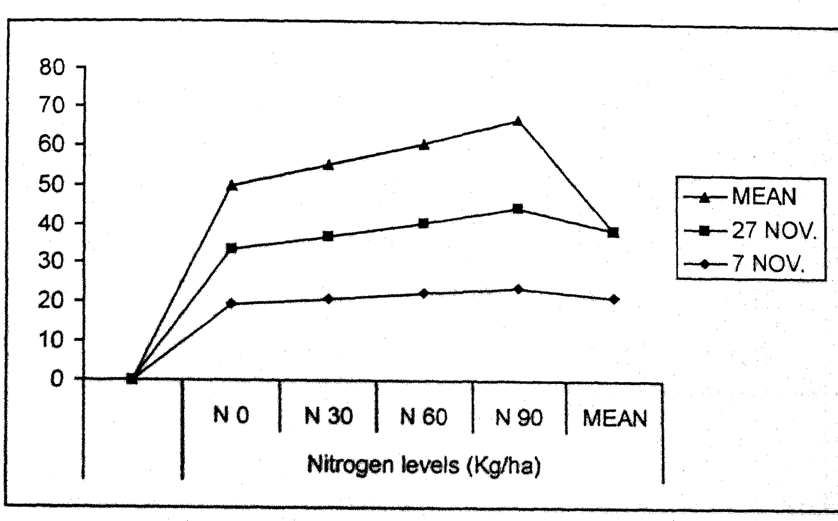


Table 4.58 No. of spikeletes/spike as influenced by various treatments and their interaction (II year).

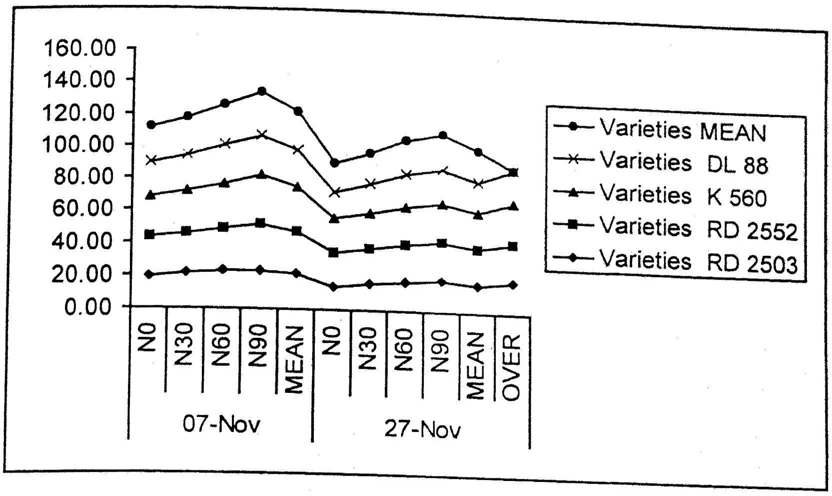
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	19.33	23.67	25.00	21.33	**22.33**
	N_{30}	21.00	24.33	26.67	22.00	**23.50**
	N_{60}	22.67	26.00	28.00	23.67	**25.08**
	N_{90}	23.00	28.67	30.33	24.67	**26.67**
	MEAN	**21.50**	**25.67**	**27.50**	**22.92**	**24.40**
27-Nov	N_0	14.00	20.33	21.67	16.00	**18.00**
	N_{30}	16.33	21.00	22.00	18.33	**19.41**
	N_{60}	17.67	22.67	23.33	20.67	**21.08**
	N_{90}	19.00	23.33	24.33	21.33	**22.00**
	MEAN	**16.75**	**21.83**	**22.83**	**19.08**	**20.12**
OVER ALL MEAN		**19.12**	**23.75**	**25.17**	**21.00**	

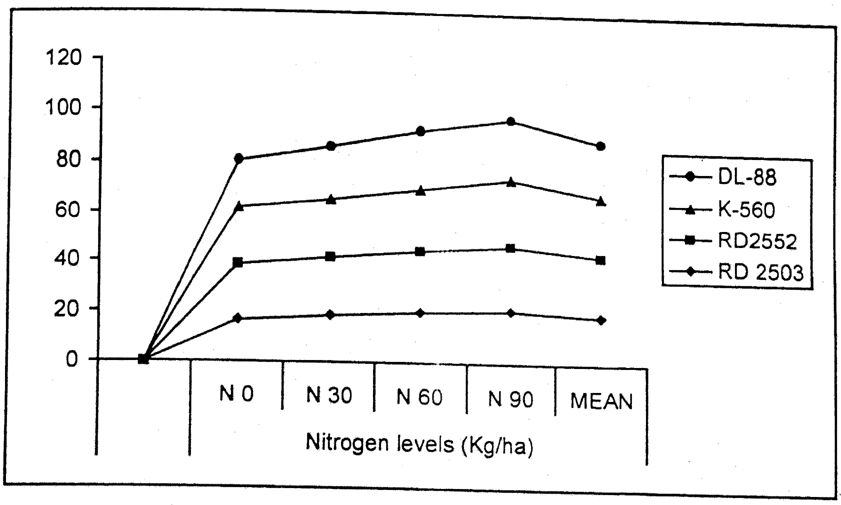
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	16.67	18.68	20.17	21.00	**19.12**
RD2552	22.00	22.67	24.34	26.00	**23.75**
K-560	23.33	24.34	25.67	27.33	**25.17**
DL-88	18.67	20.16	22.17	23.00	**21.00**

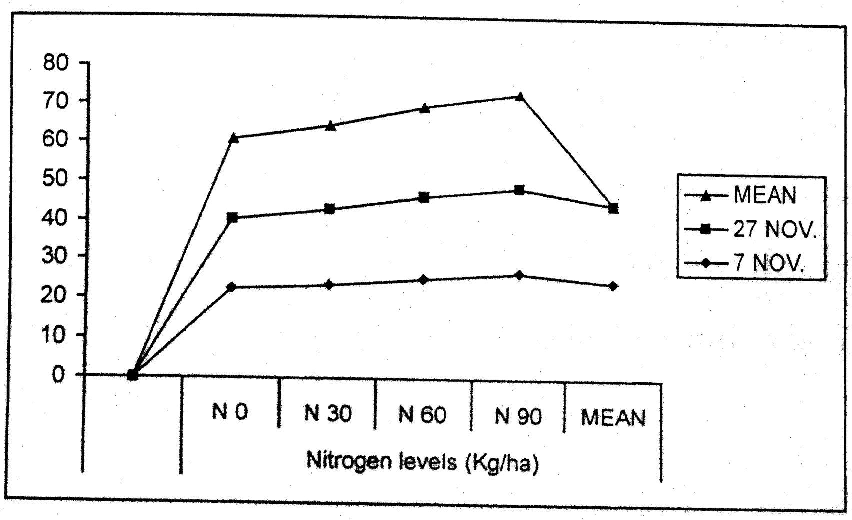
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	22.33	23.50	25.08	26.67	**24.40**
27 NOV.	18.00	19.41	21.08	22.00	**20.12**
MEAN	**20.16**	**21.45**	**23.08**	**24.33**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.19	0.15	0.30	0.26	0.52	0.37	0.35
C.D. 5%	0.47	0.34	N.S.	0.52	N.S.	N.S.	N.S.

Graph-4.58 No. of spikelets/spike as influenced by various treatments and their inateraction (II year)







similar trend was noted in second year also, but the interaction was non-significant.

4.2.4 No. of grains/spike :

The number of grains/spike ~~were~~ was also deviated significantly due to various treatments but not due to treatment interactions except in case of nitrogen x sowing date interaction (Table 4.59 and 4.60). The variety K 560 gave maximum the grain counts (65.25 and 72.37/spike in both the years), which was significantly superior to rest of the varieties. However, the second best variety was RD 2552 which gave 60.62 and 69.62 grains/spike in both the years. This was followed by DL 88 (52.50 and 60.50 grains spike) and then RD 2503 (47.50 and 55.12 grains/spike in both the years). Thus, K-560 formed 17 to 18 grains more per spike as compared to RD 2503 in both the years. Late sowing by 20 days significantly reduced the grain fromation round about 12 grains per spike over normal sown crop in both the years. Increasing levels of nitrogen increased the grain formation per spike significantly. As such, the grain number was enhanced by 12 to 17 /spike due to highest N level (N_{90}) as compared to no nitrogen (N_0) in both the years. Among the nitrogen x sowing date interactions, normal sowing with N_{90}, resulted in significantly higher grain number (69.00 and 77.25/spike in both the years) as compared to all the rest of the interactions.

Table 4.59 No. of grains/spike as influenced by various treatments and their interaction (I year).

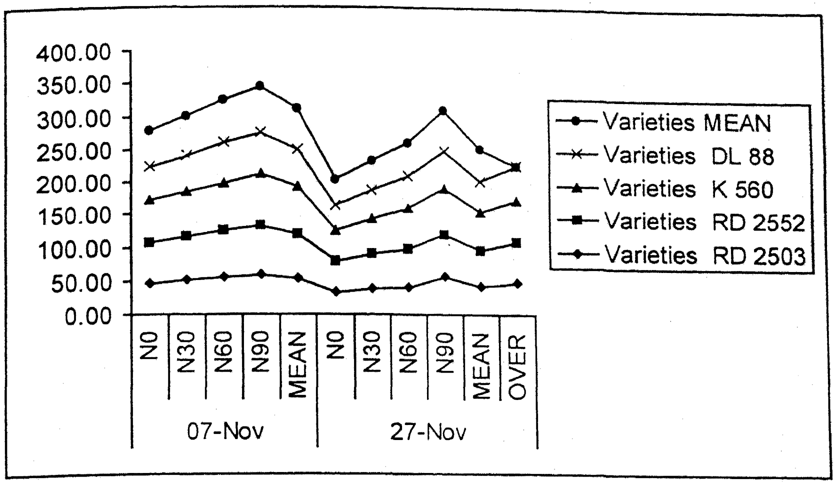
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	46.00	61.00	66.00	50.00	**55.75**
	N_{30}	52.00	63.00	71.00	55.00	**60.25**
	N_{60}	55.00	70.00	74.00	61.00	**65.00**
	N_{90}	59.00	74.00	79.00	64.00	**69.00**
	MEAN	**53.00**	**67.00**	**72.50**	**57.50**	**62.50**
27-Nov	N_0	33.00	45.00	47.00	38.00	**40.75**
	N_{30}	38.00	51.00	54.00	44.00	**46.75**
	N_{60}	41.00	57.00	61.00	50.00	**52.25**
	N_{90}	56.00	64.00	70.00	58.00	**62.00**
	MEAN	**42.00**	**54.25**	**58.00**	**47.50**	**50.44**
	OVER ALL MEAN	**47.50**	**60.62**	**65.25**	**52.50**	

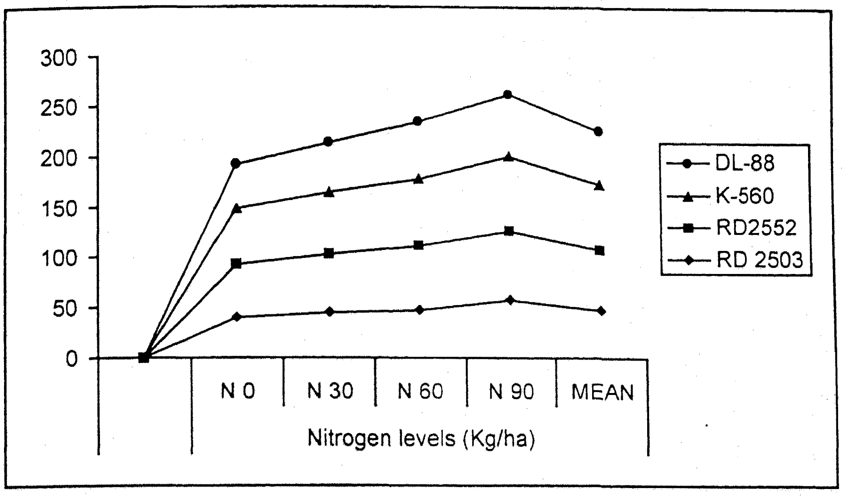
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	39.50	45.00	48.00	57.50	**47.50**
RD2552	53.00	57.00	63.50	69.00	**60.62**
K-560	56.50	62.50	67.50	74.50	**65.25**
DL-88	44.00	49.50	55.50	61.00	**52.50**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	55.75	60.25	65.00	69.00	**62.50**
27 NOV.	40.75	46.75	52.25	62.00	**50.44**
MEAN	**48.25**	**53.50**	**58.62**	**65.50**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.79	0.21	0.42	0.72	1.43	1.01	0.90
C.D. 5%	1.95	0.49	0.97	1.44	N.S.	2.04	N.S.

Graph-4.59 **No. of grains/spike as influenced by various treatments and their inateraction (I year)**





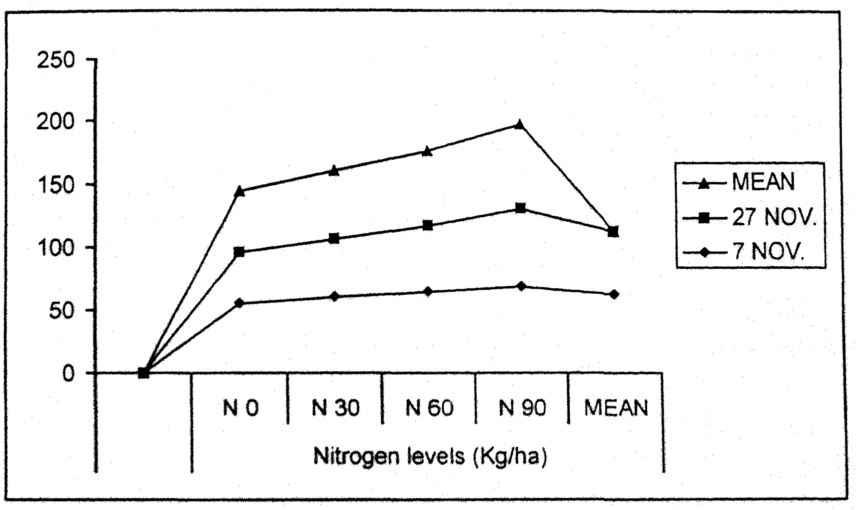


Table 4.60 No. of grains/spike as influenced by various treatments and their interaction (II year).

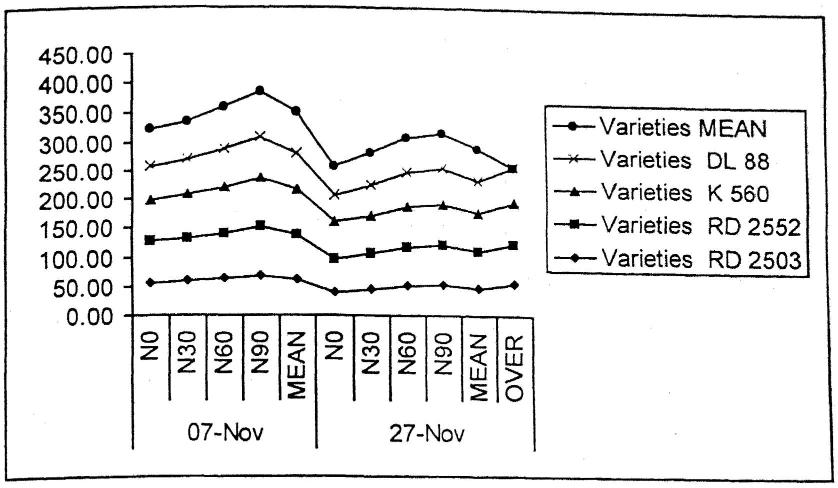
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	56.00	71.00	72.00	60.00	**64.75**
	N_{30}	60.00	72.00	76.00	62.00	**67.50**
	N_{60}	65.00	76.00	80.00	68.00	**72.25**
	N_{90}	68.00	84.00	86.00	71.00	**77.25**
	MEAN	**62.25**	**75.75**	**78.50**	**65.25**	**70.44**
27-Nov	N_0	40.00	58.00	62.00	46.00	**51.50**
	N_{30}	46.00	62.00	64.00	54.00	**56.50**
	N_{60}	52.00	66.00	69.00	60.00	**61.75**
	N_{90}	54.00	68.00	70.00	63.00	**63.75**
	MEAN	**48.00**	**63.50**	**66.25**	**55.75**	**58.37**
	OVER ALL MEAN	**55.12**	**69.62**	**72.37**	**60.50**	

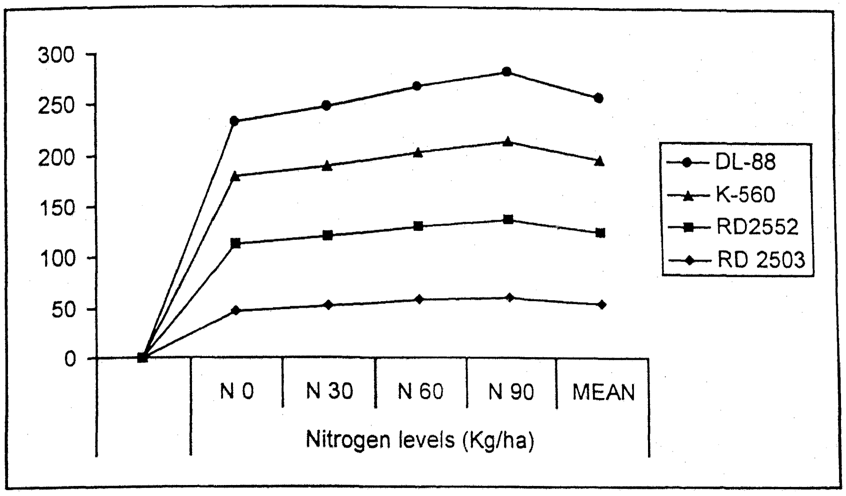
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	48.00	53.00	58.51	61.00	**55.12**
RD2552	64.50	67.00	71.00	76.00	**69.62**
K-560	67.00	70.00	74.50	78.00	**72.37**
DL-88	53.00	58.00	64.00	67.00	**60.50**

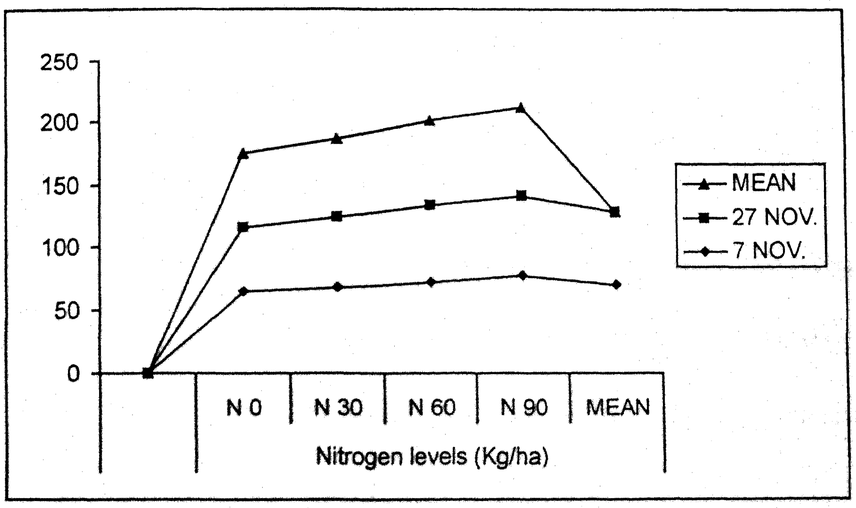
Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	64.75	67.50	72.25	77.25	**70.44**
27 NOV.	51.50	56.50	61.75	63.75	**58.37**
MEAN	**58.12**	**62.00**	**67.00**	**70.50**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.92	0.62	1.24	0.53	1.07	0.76	0.90
C.D. 5%	2.25	1.43	N.S.	1.07	N.S.	1.52	N.S.

Graph-4.60 **No. of grains/spike as influenced by various treatments and their inateraction (II year)**







4.2.5 Grain weight/spike :

This parameter was found to deviate significantly due to various treatments as well as all the treatment interactions in both the years indicated in Table 4.61 and 4.62. The results followed the same trend as revealed from earlier observations in yield components. K 560 proved the best (2.79 and 3.10 g/spike), being significantly higher to those of rest of the varieties. RD 2552 was the second best, followed by DL 88 and then RD 2503. The lowest grain weight (1.90 and 2.21 g) was obtained from RD 2503 variety. Late sowing discouraged the grain weight, while increasing levels of nitrogen encouraged it significantly in both the years. Treatment interactions further augmented this parameter. The best treatment interaction was K 560 grown with normal sowing date (7 November) and applied with highest N level (N_{90}) which resulted with maximum grain weight (3.39 and 3.70 g/spike in both the years), being significantly superior to all the rest of the treatment interactions. Similarly, K 560 either with normal sowing or with N_{90} performed the best over their respective combinations. Normal sowing with N_{90} also gave the similar response.

4.2.6 Test weight of 1000 grains :

The test weight was changed significantly due to various treatments and treatment interactions in both the years as revealed from Table 4.63 and 4.64. Amongst the varieites, K-560 recorded

Table 4.61 No. of grain weight/spike as influenced by various treatments and their interaction (I year).

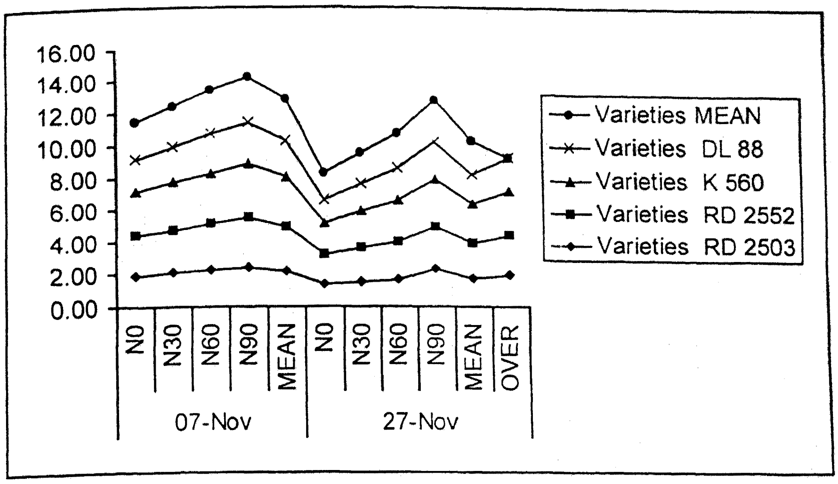
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	1.84	2.55	2.82	1.96	**2.29**
	N_{30}	2.09	2.64	3.04	2.16	**2.48**
	N_{60}	2.22	2.94	3.17	2.40	**2.68**
	N_{90}	2.38	3.11	3.39	2.52	**2.85**
	MEAN	**2.13**	**2.81**	**3.10**	**2.26**	**2.57**
27-Nov	N_0	1.29	1.87	1.97	1.48	**1.65**
	N_{30}	1.49	2.12	2.31	1.72	**1.91**
	N_{60}	1.62	2.37	2.61	1.96	**2.14**
	N_{90}	2.25	2.67	3.00	2.28	**2.55**
	MEAN	**1.66**	**2.26**	**2.47**	**1.86**	**2.06**
OVER ALL MEAN		**1.90**	**2.53**	**2.79**	**2.06**	

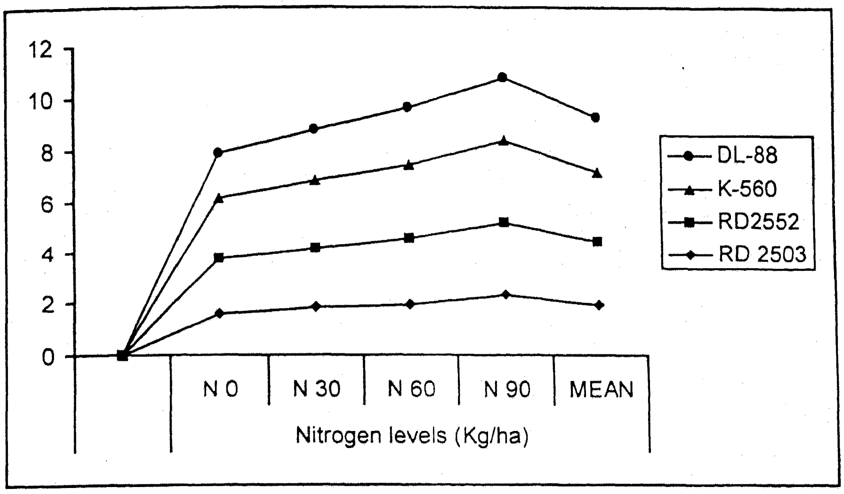
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	1.56	1.79	1.92	2.31	**1.90**
RD2552	2.21	2.38	2.65	2.89	**2.53**
K-560	2.39	2.67	2.89	3.19	**2.79**
DL-88	1.72	1.94	2.18	2.40	**2.06**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	2.29	2.48	2.68	2.85	**2.57**
27 NOV.	1.65	1.91	2.14	2.55	**2.06**
MEAN	**1.97**	**2.19**	**2.41**	**2.70**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D. 5%	0.02	0.01	0.03	0.01	0.03	0.02	0.02

Graph-4.61 No. of grain weight/spike as influenced by various treatments and their inateraction (I year)





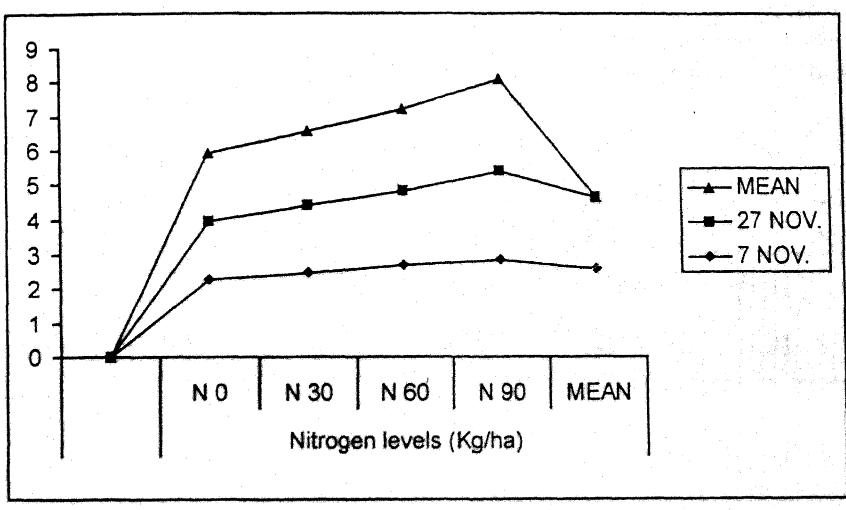


Table 4.62 No. of grain weight/spike (Y) as influenced by various treatments and their interaction (II year).

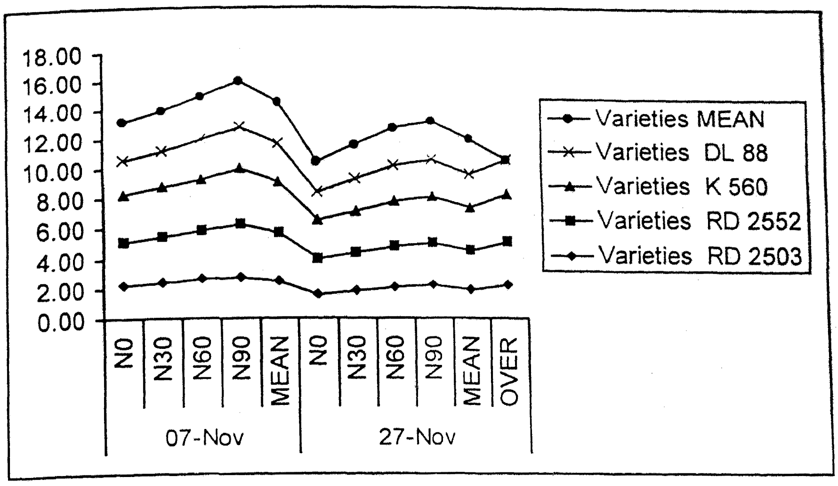
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	2.23	2.93	3.08	2.35	**2.65**
	N_{30}	2.43	3.03	3.26	2.44	**2.79**
	N_{60}	2.63	3.21	3.44	2.68	**2.99**
	N_{90}	2.76	3.55	3.70	2.80	**3.20**
	MEAN	**2.51**	**3.18**	**3.37**	**2.57**	**2.91**
27-Nov	N_0	1.56	2.37	2.60	1.79	**2.08**
	N_{30}	1.82	2.58	2.74	2.12	**2.31**
	N_{60}	2.07	2.76	2.96	2.36	**2.54**
	N_{90}	2.19	2.86	3.01	2.48	**2.63**
	MEAN	**1.91**	**2.64**	**2.83**	**2.19**	**2.39**
OVER ALL MEAN		**2.21**	**2.91**	**3.10**	**2.38**	

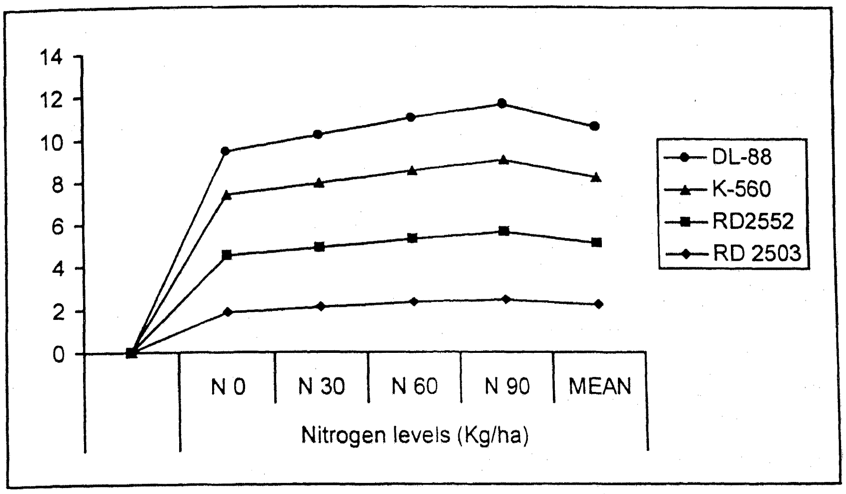
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	1.89	2.12	2.35	2.47	2.21
RD2552	2.65	2.80	2.98	3.20	2.91
K-560	2.84	3.00	3.20	3.35	3.10
DL-88	2.07	2.28	2.52	2.64	2.38

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	2.65	2.79	2.99	3.20	**2.91**
27 NOV.	2.08	2.31	2.54	2.63	**2.39**
MEAN	**2.36**	**2.55**	**2.76**	**2.91**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D. 5%	0.02	0.01	0.03	0.01	0.02	0.01	0.02

Graph-4.62 No. of grain weight/spike (g) as influenced by various treatments and their inateraction (II year)





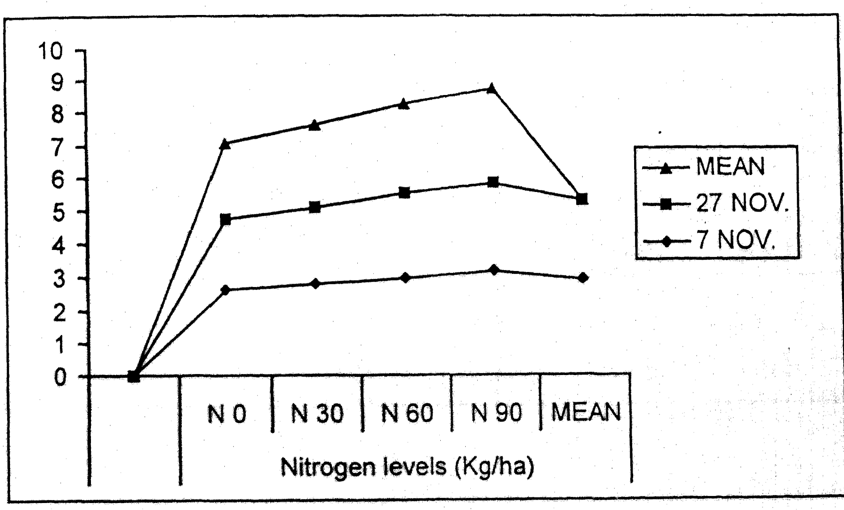


Table 4.63 **Test weight (gm) as influenced by various treatments and their interaction (I year).**

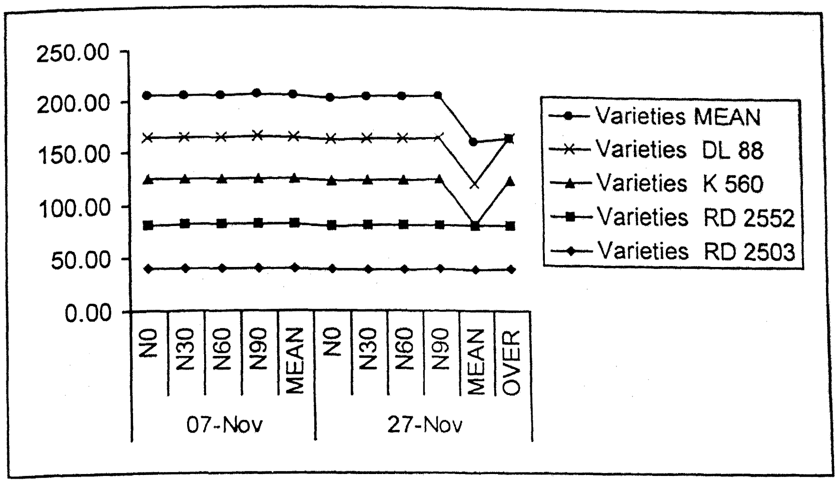
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	39.95	41.90	42.78	39.21	**40.96**
	N_{30}	40.18	41.94	42.86	39.26	**41.06**
	N_{60}	40.32	41.96	42.89	39.34	**41.13**
	N_{90}	40.38	41.98	42.96	39.36	**41.17**
	MEAN	**40.21**	**41.92**	**42.87**	**39.29**	**41.08**
27-Nov	N_0	39.22	41.52	41.90	39.05	**40.42**
	N_{30}	39.32	41.58	42.83	39.12	**40.72**
	N_{60}	39.43	41.63	42.85	39.20	**40.79**
	N_{90}	40.15	41.67	42.92	39.31	**41.01**
	MEAN	**39.53**	**41.60**	**42.62.**	**39.17**	**40.73**
OVER ALL MEAN		**39.87**	**41.76**	**42.75**	**39.23**	

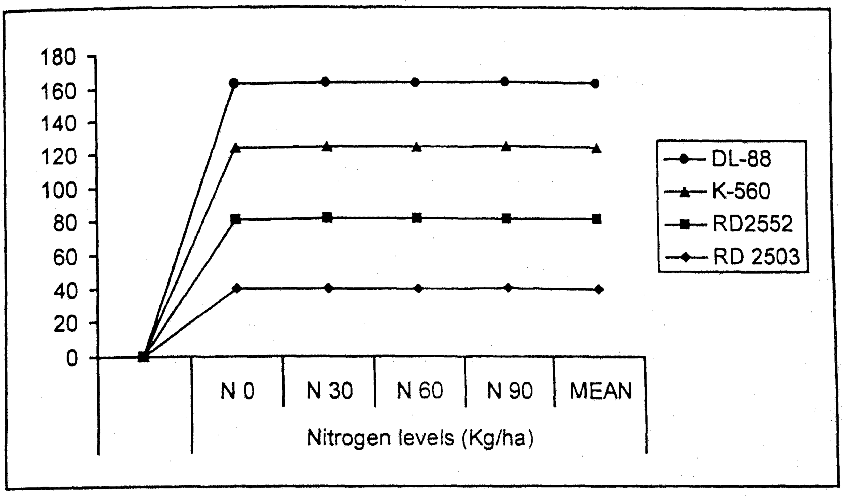
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	39.58	39.75	39.87	40.26	**39.87**
RD2552	41.71	41.76	41.79	41.82	**41.76**
K-560	42.34	42.84	42.87	42.94	**42.75**
DL-88	39.13	39.19	39.27	39.33	**39.23**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	40.96	41.06	41.13	41.17	**41.07**
27 NOV.	40.42	40.72	40.79	41.01	**40.73**
MEAN	**40.69**	**40.89**	**40.96**	**41.09**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.10	0.07	0.14	0.10	0.21	0.14	0.14
C.D. 5%	0.24	0.17	N.S.	0.21	N.S.	N.S.	N.S.

Graph-4.63 Test weight (gm) as influenced by various treatments and their inateraction (I year)





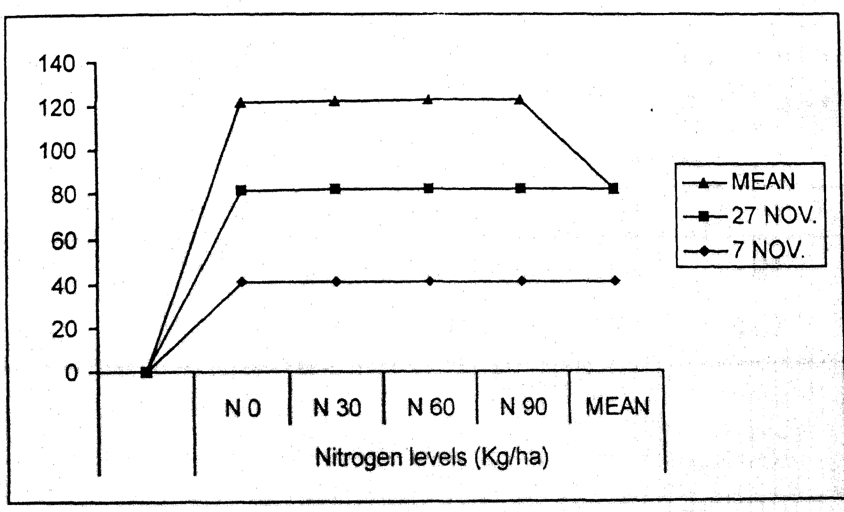


Table 4.64 Test weight (gm) as influenced by various treatments and their interaction (II year).

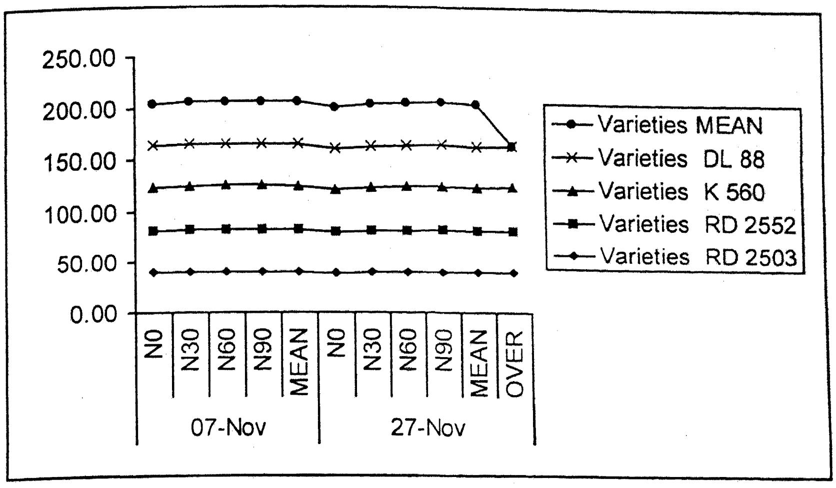
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	39.76	41.73	42.85	39.20	**40.88**
	N_{30}	40.48	42.14	42.90	39.33	**41.21**
	N_{60}	40.52	42.22	42.95	39.38	**41.27**
	N_{90}	40.60	42.30	43.00	39.45	**41.34**
	MEAN	**40.34**	**42.10**	**42.92**	**39.34**	**41.17**
27-Nov	N_0	38.91	40.82	41.95	38.90	**40.14**
	N_{30}	39.64	41.57	42.88	39.20	**40.82**
	N_{60}	39.87	41.84	42.91	39.32	**40.98**
	N_{90}	40.53	42.05	42.95	39.38	**41.23**
	MEAN	**39.74**	**41.57**	**42.67**	**39.20**	**40.80**
OVER ALL MEAN		**40.04**	**41.83**	**42.80**	**39.27**	

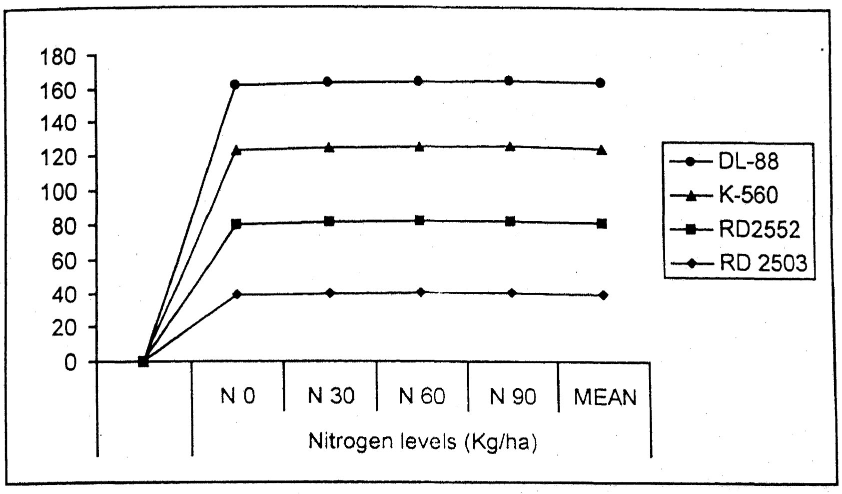
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	39.33	40.06	40.19	40.56	**40.04**
RD2552	41.27	41.58	42.03	42.17	**41.83**
K-560	42.40	42.89	42.93	42.97	**42.80**
DL-88	39.05	39.26	39.35	39.41	**39.27**

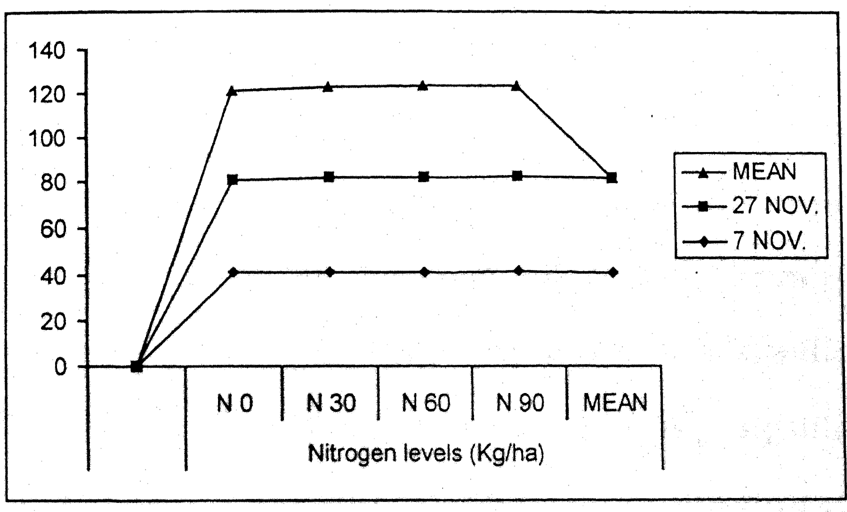
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	40.88	41.21	41.27	41.34	**41.17**
27 NOV.	40.14	40.82	40.98	41.23	**40.80**
MEAN	**40.51**	**41.01**	**41.12**	**41.28**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.24	0.95	1.90	1.29	2.58	1.82	1.84
C.D. 5%	N.S.	N.S.	N.S.	N.S.	5.19	3.67	3.85

Graph-4.64 **Test weight (gm) as influenced by various treatments and their inateraction (II year)**







maximum test weight (42.75 and 42.80 g in both the years), being significantly superior to rest of the varieties only in first year. This was followed by RD 2552, RD 2503 and the then DL 88. Late sowing discouraged this parameter and increasing N-levels encouraged it significantly only in first year. The treatment interactions were found significant only in second year. Accordingly, K 560 sown on normal date with N_{90} resulted in the highest test weight upto 43.0 g, being significantly higher to most of the interactions. The variety x sowing date interaction was non-significant in both the years. K-560 with N_{90} and normal date x N_{90} also performed the best over rest of the respective treatment combinations.

4.2.7 Yield attributes at a glance :

The two years mean data on yield-attributes have been highlighted in the summary Tabel 4.65 covering the mean values of both the years.

The number of spikes/plant was maximum (6.29) in variety RD 2552, but other characters viz. spike length (9.80 cm), spikelets/spike (23.83), grains/spike (68.81), grain weight/spike (2.94 g) and 1000 grain weight (42.77 g) were maximum in variety K 560. However, this was followed by RD 2552 in these five characters. RD 2503 gave the minimum values in all these yield-components. In late sown crop, these characters were significantly discouraged, whereas increasing N-levels upto N_{90} significantly

Summary table -4.65

Yield attributes at a glance (a)

Treatments	Yield attributes as influnced by different treatments																	
Main plot treatments	No of spikes per plant			Spike length (cm)			No of spikelets/spike			No of grains /spike			Grain weight / Spike			Test weight (gm)		
Varieties	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**
V_1	3.42	4.75	**4.08**	5.72	6.40	**6.06**	16.24	19.12	**17.68**	47.50	55.12	**51.31**	1.90	2.21	**2.05**	39.87	40.04	**39.95**
V_2	6.12	6.46	**6.29**	8.03	9.94	**8.98**	20.45	23.75	**22.10**	60.62	69.62	**65.12**	2.53	2.91	**2.72**	41.76	41.83	**41.79**
V_3	3.08	4.41	**3.74**	8.91	10.70	**9.80**	22.66	25.00	**23.83**	65.25	72.37	**68.81**	2.79	3.10	**2.94**	42.75	42.80	**42.77**
V_4	4.37	5.13	**4.75**	7.07	8.12	**7.59**	18.16	21.00	**19.58**	52.50	60.50	**56.50**	2.06	2.38	**2.22**	39.23	39.27	**39.25**
C.D.(5%)	0.30	0.34	**0.32**	0.69	0.62	**0.65**	0.83	0.47	**0.65**	1.95	2.25	**2.10**	0.02	0.02	**0.02**	0.24	N.S.	**0.14**
Sub plot treat.																		
Date of sowing																		
D_1	4.68	5.46	**5.07**	7.99	9.24	**8.61**	21.52	24.40	**22.96**	62.50	70.44	**66.47**	2.57	2.91	**2.74**	41.07	41.17	**41.12**
D_2	3.81	4.92	**4.36**	6.89	8.34	**7.61**	17.25	20.12	**18.68**	50.44	58.37	**54.40**	2.06	2.39	**2.22**	40.73	40.80	**40.76**
C.D.(5%)	0.41	0.32	**0.36**	0.35	0.51	**0.43**	0.47	0.34	**0.40**	0.49	1.43	**0.96**	0.01	0.01	**0.01**	0.17	N.S.	**0.10**
Sub sub plot treatments																		
N-levels (Kg/ha.)																		
N_1	3.33	4.59	**3.96**	6.31	7.69	**7.00**	16.66	20.16	**18.41**	48.25	58.12	**53.18**	1.97	2.36	**2.16**	40.69	40.51	**40.60**
N_2	3.71	4.96	**4.33**	6.98	8.39	**7.68**	18.37	21.45	**19.91**	53.50	62.00	**57.75**	2.19	2.55	**2.37**	40.89	41.01	**40.95**
N_3	4.66	5.42	**5.04**	7.82	9.23	**8.52**	20.20	23.08	**21.64**	58.62	67.00	**62.81**	2.41	2.76	**2.58**	40.96	41.12	**41.04**
N_4	5.29	5.79	**5.52**	8.63	9.84	**9.35**	22.29	24.33	**23.31**	65.50	70.50	**68.00**	2.70	2.91	**2.80**	41.09	41.28	**41.18**
C.D.(5%)	0.51	0.45	**0.48**	0.59	0.48	**0.53**	0.70	0.52	**0.61**	1.44	1.08	**1.26**	0.01	0.01	**0.01**	0.21	N.S.	**0.16**
Interaction																		
VxD	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		0.97	N.S.		0.03	0.03		N.S.	N.S.	
VxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		0.03	0.02		N.S.	5.19	
DxN	N.S.	N.S.		N.S.	N.S.		0.99	N.S.		2.04	1.52		0.02	0.01		N.S.	3.66	
VxDxN	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		0.02	0.02		N.S.	3.85	

encouraged all these characters. The treatment interactions were found to be non-significant in most of the characters.

4.3 Productivity and net-return :

4.3.1 Grain yield per hectare :

The data on grain yield per hectare indicate that the various treatments and the treatment interactions were found to exert significant influence in both the years (Table 4.66 and 4.67). The variety RD 2552 performed the best. It yielded 40.95 q/ha in first year and 42.45 q/ha in second year, being significantly higher to RD 2503, K 560 and DL 88 varieties. However, the second best variety was DL 88 which yielded 39.07 and 41.04 q/ha in respective years. This was followed by RD 2503 (36.82 and 37.76 q/ha), and then K 560 (32.13 and 34.07 q/ha in both the years). Late sowing on 27 November resulted in significantly lower yield (35.82 and 37.51 q/ha) as against the normal sowing date (38.66 and 40.14 q/ha in respective years), The mean decrease in yield being upto 2.70 q/ha. The increasing levels of nitrogen upto N_{90} increased the grain yield significantly in both the years. Thus, the maximum yield went upto 44.96 to 46.05 q/ha at N_{90} level of nitrogen as against 30.40 to 32.43 q/ha at No level of nitrogen (control), the difference being round about 14 q/ha. None of the treatment interactions were found significant except nitrogen x variety interaction in first year which was significant. This interaction

Table 4.66 Grain yield (q/ha.) as influenced by various treatments and their interaction (I year).

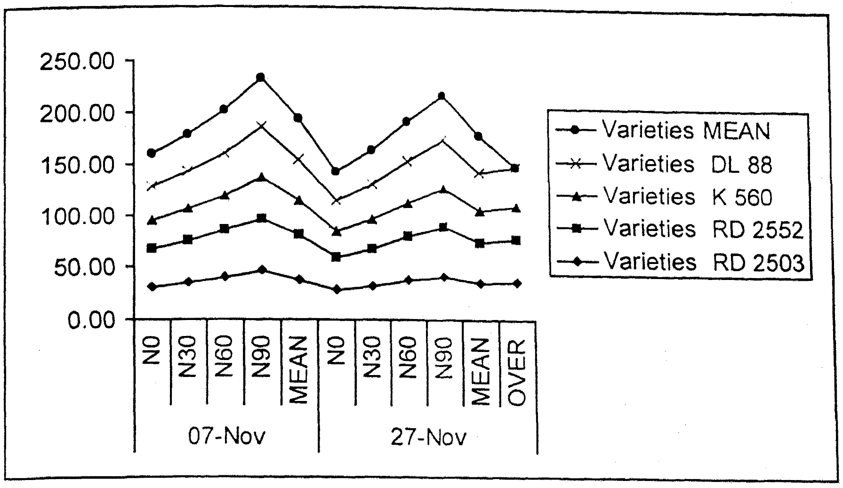
Date of sowing	Nitrogen levels (Kg/ha)	Varieties RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	31.46	36.06	27.29	33.37	**32.04**
	N_{30}	36.06	39.97	30.15	37.37	**35.89**
	N_{60}	39.62	46.06	33.19	42.15	**40.25**
	N_{90}	46.49	49.53	41.54	48.32	**46.47**
	MEAN	**38.41**	**42.90**	**33.04**	**40.30**	**38.66**
27-Nov	N_0	29.20	29.98	26.07	29.80	**28.76**
	N_{30}	32.41	35.63	28.07	35.10	**32.80**
	N_{60}	37.80	43.01	31.89	40.41	**38.28**
	N_{90}	41.54	47.36	38.84	46.06	**43.45**
	MEAN	**35.24**	**38.99**	**31.22**	**37.84**	**35.82**
	OVER ALL MEAN	**36.82**	**40.95**	**32.13**	**39.07**	

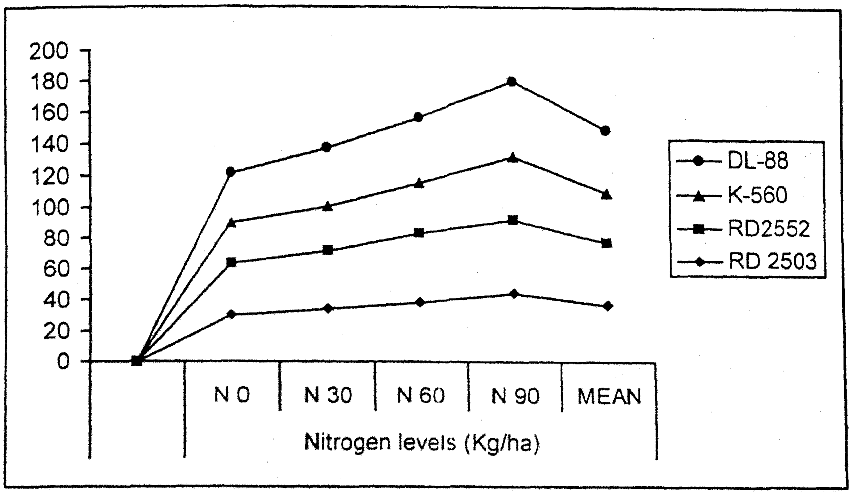
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	30.33	34.23	38.71	44.01	**36.82**
RD2552	33.02	37.80	44.53	48.44	**40.95**
K-560	26.68	29.11	32.54	40.19	**32.13**
DL-88	31.58	36.23	41.28	47.19	**39.07**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	32.04	35.89	40.25	46.47	**38.66**
27 NOV.	28.76	32.80	38.28	43.45	**35.82**
MEAN	**30.40**	**34.34**	**39.26**	**44.96**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em ±	0.54	0.27	0.55	0.45	0.91	0.64	0.62
C.D. 5%	1.33	0.63	N.S.	0.91	1.83	N.S.	N.S.

Graph-4.66 **Grain yield (q/ha.) as influenced by various treatments and their inateraction (I year)**





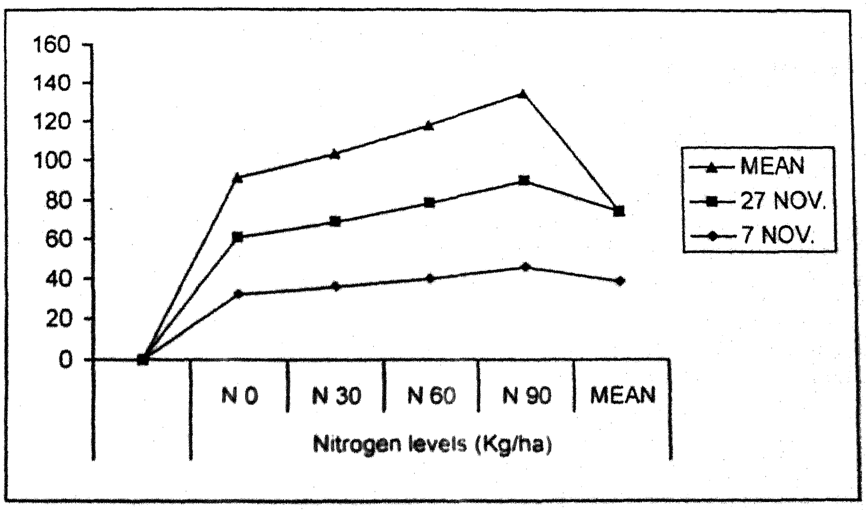


Table 4.67 **Grain yield (q/ha.) as influenced by various treatments and their interaction (II year).**

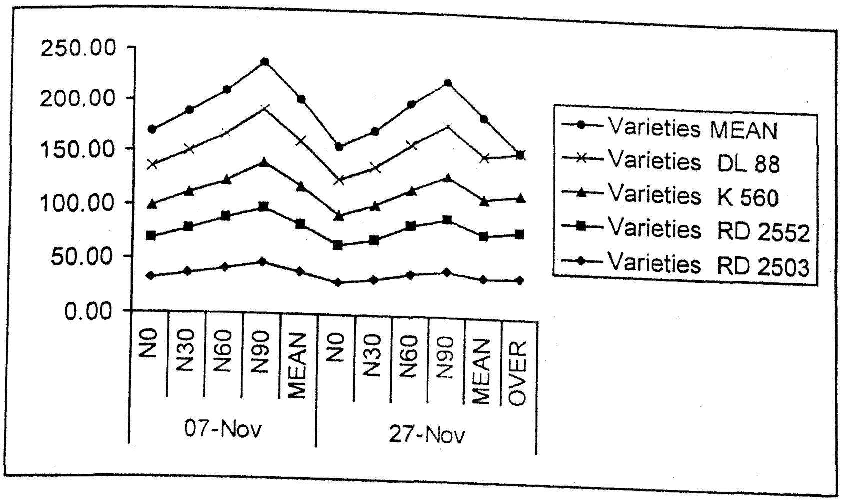
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	32.15	36.84	30.15	35.80	**33.73**
	N_{30}	36.93	41.36	32.50	39.89	**37.67**
	N_{60}	41.10	47.19	34.41	43.97	**41.67**
	N_{90}	46.58	50.49	42.75	50.23	**47.51**
	MEAN	**39.19**	**43.67**	**34.95**	**42.47**	**40.14**
27-Nov	N_0	30.15	33.80	28.24	32.33	**31.13**
	N_{30}	33.55	36.50	31.54	36.15	**34.43**
	N_{60}	39.45	44.75	32.85	42.49	**39.88**
	N_{90}	42.15	48.66	40.15	47.45	**44.60**
	MEAN	**36.32**	**40.93**	**33.19**	**39.60**	**37.51**
OVER ALL MEAN		**37.76**	**42.45**	**34.07**	**41.04**	

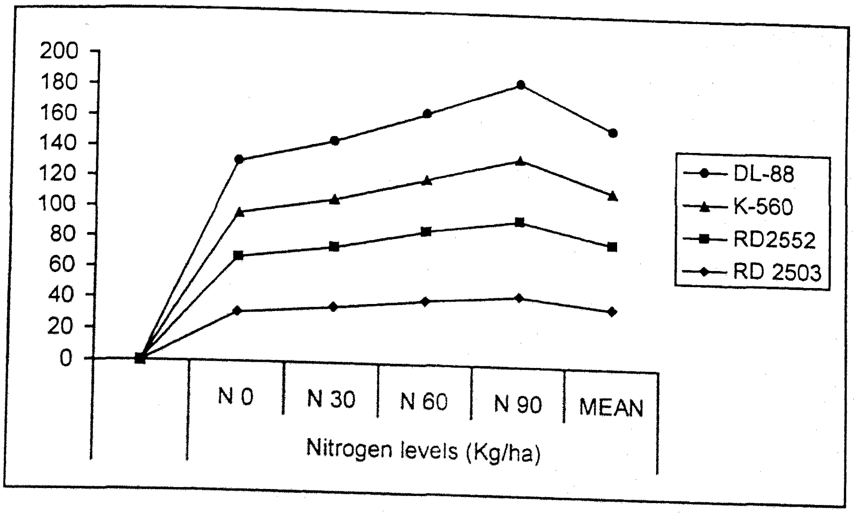
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	31.15	35.24	40.27	44.36	**37.76**
RD2552	35.32	38.93	45.97	49.57	**42.45**
K-560	29.19	32.02	33.63	41.45	**34.07**
DL-88	34.06	38.02	43.23	48.84	**41.04**

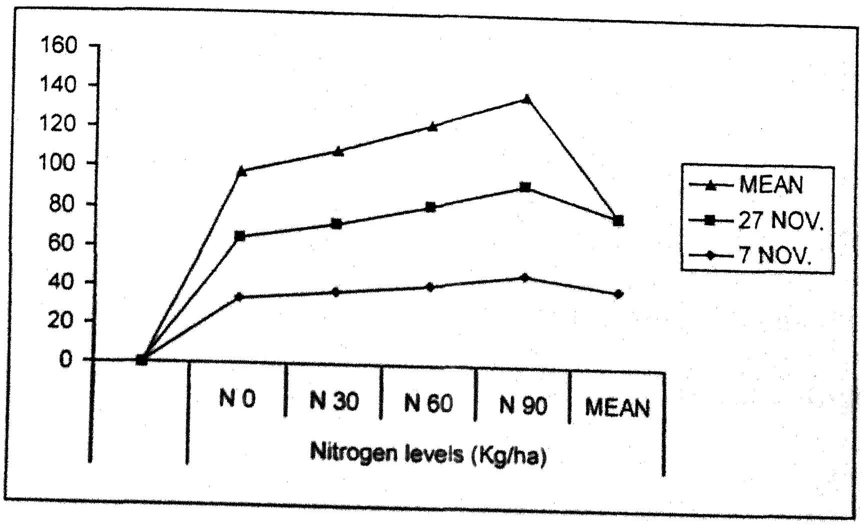
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	33.73	37.67	41.67	47.51	**40.14**
27 NOV.	31.13	34.43	39.88	44.60	**37.51**
MEAN	**32.43**	**36.05**	**40.77**	**46.05**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.57	0.26	0.52	0.59	1.19	0.84	0.77
C.D. 5%	1.40	0.60	N.S.	1.20	N.S.	N.S.	N.S.

Graph-4.67 **Grain yield (q/ha.) as influenced by various treatments and their inateraction (II year)**







further augmented the grain yield (48.44 and 49.57 q/ha in the respective years). This was followed by DL 88 at N_{90} level of nitrogen (47.19 and 48.84 q/ha).

4.3.2 Straw yield per hectare :

results

The result trend was exactly the same as obtained in case of grain yield in both the years as highlighted in Table 4.68 and 4.69. None of the treatment interactions were found significant in both the years. RD 2552 and DL 88 resulted in almost equally higher straw yield over rest of the varieties (RD 2503 and K 560), the straw yield being 62.49 to 63.93 q/ha in first year and 64.40 to 65.70 q/ha in second year. K 560 produced the lowest straw (56.07 and 57.98 q/ha in respective years). Late sowing reduced the straw yield considerably. However, increasing levels of nitrogen upto N_{90} increased the straw yield significantly. Accordingly, the maximum straw yield at N_{90} was 67.16 and 68.30 q/ha in both the years, whereas the straw yield in control (N_0) was only 55.10 and 57.79 q/ha in the respective years), the mean difference being round about 11 to 12 q/ha.

4.3.3 Harvest index (HI) :

presented

The data on harvest index as depicted in Table 4.70 and 4.71 clearly indicate the same trend as observed in case of grain and straw yield in both the years. The HI was equally higher in varieties RD 2552 and DL 88 (38.33 to 38.89% in first year, and

Table 4.68 **Straw yield (q/ha.) as influenced by various treatments and their interaction (I year).**

Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	56.31	59.53	52.14	57.79	**56.44**
	N_{30}	61.87	64.31	54.31	62.39	**60.72**
	N_{60}	62.48	66.48	56.05	63.26	**62.07**
	N_{90}	67.78	71.26	64.31	69.52	**68.22**
	MEAN	**62.11**	**65.39**	**56.70**	**63.24**	**61.86**
27-Nov	N_0	54.75	53.87	51.27	55.18	**53.77**
	N_{30}	57.35	60.39	53.18	61.87	**60.65**
	N_{60}	60.39	65.17	55.18	60.83	**57.94**
	N_{90}	62.71	70.47	62.13	69.08	**66.10**
	MEAN	58.80	62.47	55.44	61.74	59.61
	OVER ALL MEAN	60.45	63.93	56.07	62.49	

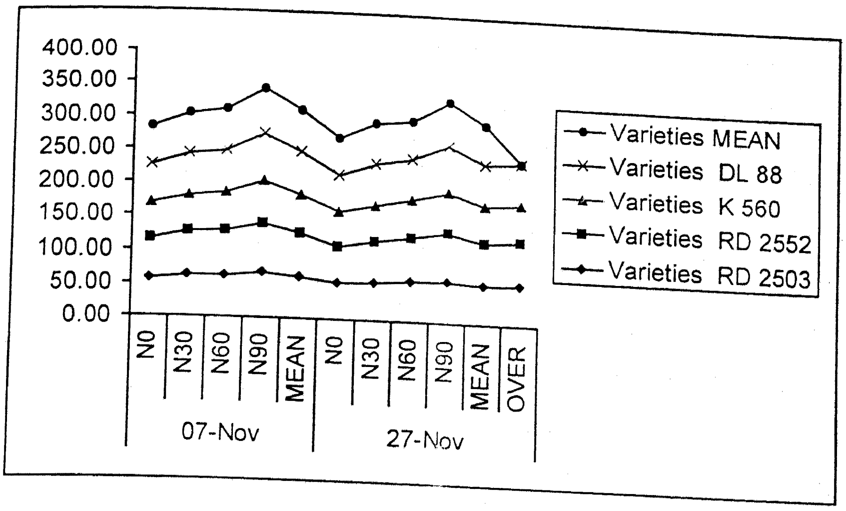
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	55.53	59.61	61.43	65.24	**60.45**
RD2552	56.70	62.35	65.82	70.86	**63.93**
K-560	51.70	53.74	55.61	63.22	**56.07**
DL-88	56.48	61.61	62.56	69.30	**62.49**

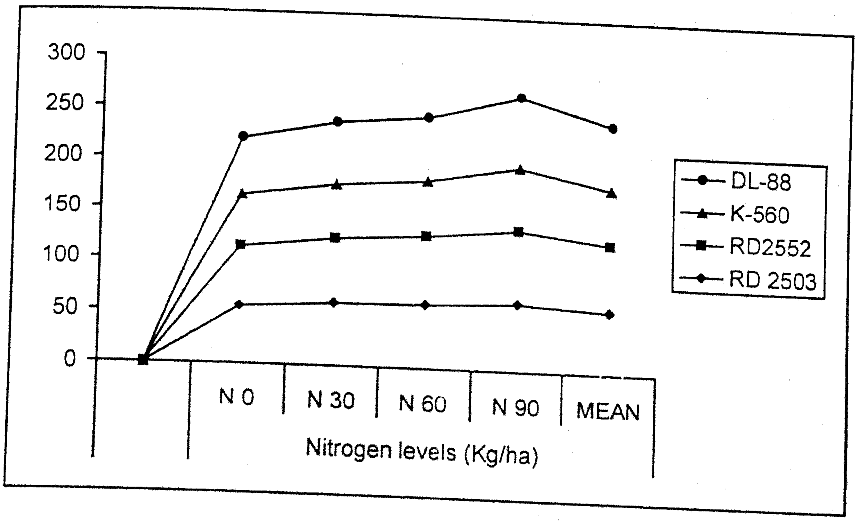
(Nitrogen levels (Kg/ha))

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	56.44	60.72	62.07	68.22	**61.86**
27 NOV.	53.77	57.94	60.65	66.10	**59.61**
MEAN	**55.10**	**59.33**	**61.36**	**67.16**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.24	1.05	2.10	1.28	2.57	1.81	1.89
C.D. 5%	3.05	N.S.	N.S.	2.58	N.S.	N.S.	N.S.

Graph-4.68 **Straw yield (q/ha.) as influenced by various treatments and their inateraction (I year)**





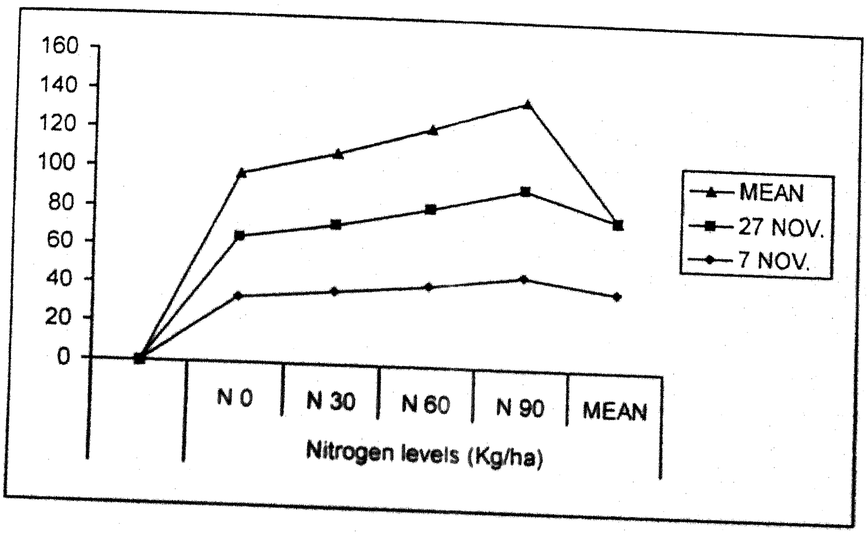


Table 4.69 Straw yield (q/ha.) as influenced by various treatments and their interaction (II year).

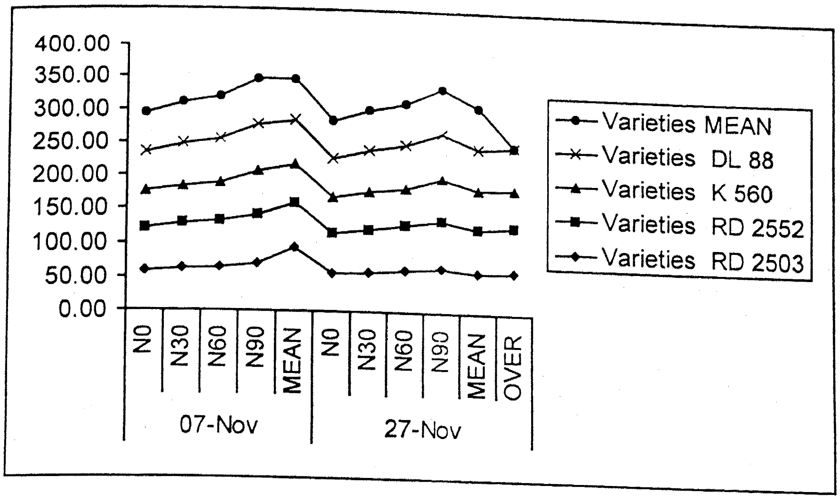
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	58.22	62.20	55.35	59.26	**58.76**
	N_{30}	63.00	65.35	55.70	63.70	**61.94**
	N_{60}	64.20	67.78	57.01	66.22	**63.80**
	N_{90}	69.17	71.69	65.61	71.43	**69.47**
	MEAN	**93.65**	**66.75**	**58.42**	**65.15**	**63.49**
27-Nov	N_0	56.53	59.35	53.53	57.88	**56.82**
	N_{30}	58.57	63.44	55.44	63.00	**60.11**
	N_{60}	61.52	66.39	56.40	65.09	**62.35**
	N_{90}	65.70	69.35	64.83	68.65	**67.13**
	MEAN	**60.58**	**64.63**	**57.55**	**63.65**	**61.60**
OVER ALL MEAN		**62.11**	**65.70**	**57.98**	**64.40**	

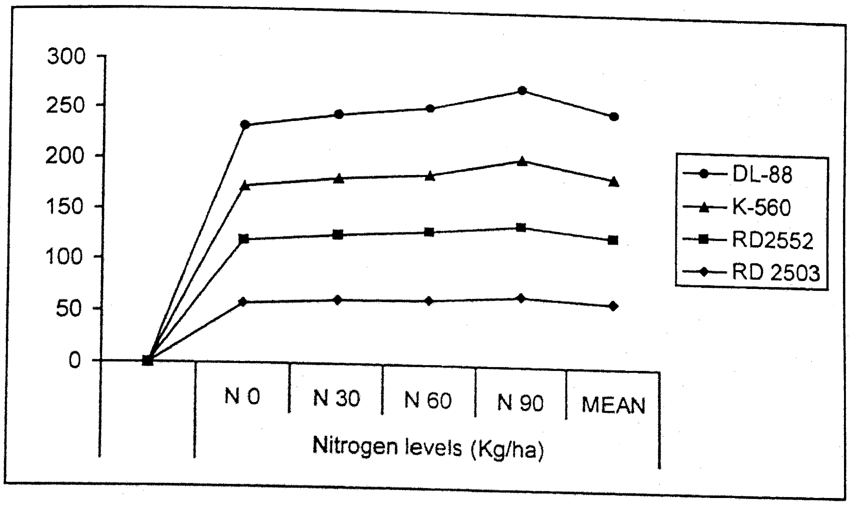
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	57.37	60.78	62.86	67.43	**62.11**
RD2552	60.77	64.50	67.09	70.52	**65.70**
K-560	54.44	55.57	56.70	65.22	**57.98**
DL-88	58.57	63.35	65.65	70.04	**64.40**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	58.76	61.94	63.80	69.47	**63.49**
27 NOV.	56.82	60.11	62.35	67.13	**61.60**
MEAN	**57.79**	**61.02**	**63.07**	**68.30**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	1.41	0.83	1.65	0.94	1.89	1.33	1.42
C.D. 5%	3.46	1.91	N.S.	1.90	N.S.	N.S.	N.S.

Graph-4.69 **Straw yield (q/ha.) as influenced by various treatments and their inateraction (II year)**





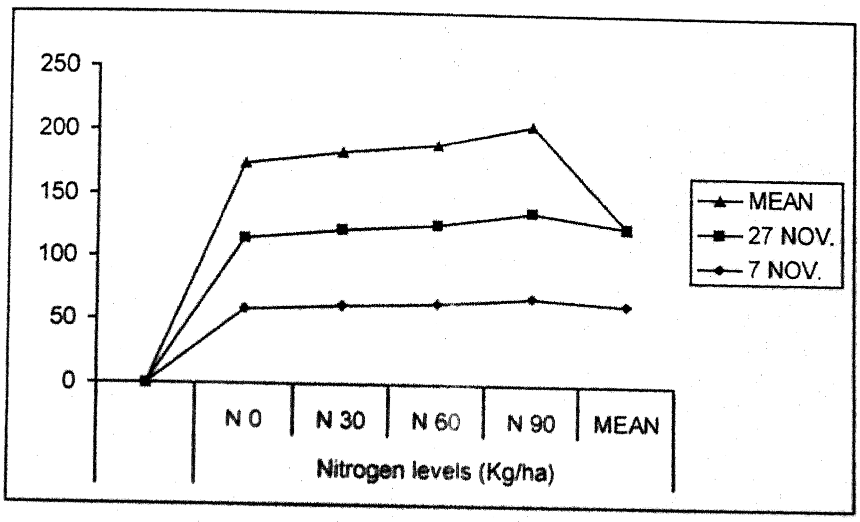


Table 4.70 Harvest index (%) as influenced by various treatments and their interaction (I year).

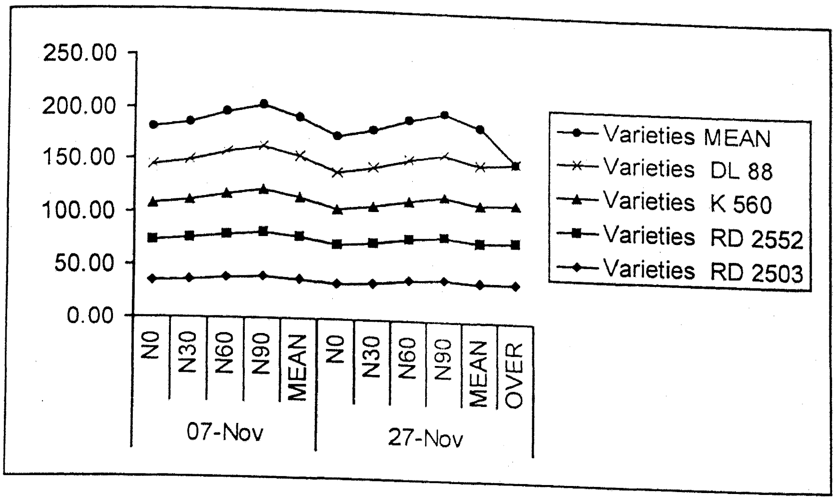
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	35.85	37.74	34.49	36.61	**36.17**
	N_{30}	37.20	38.34	35.70	37.47	**37.18**
	N_{60}	38.76	40.94	37.29	39.98	**39.24**
	N_{90}	40.68	41.19	39.46	41.02	**40.59**
	MEAN	**38.12**	**39.55**	**36.73**	**38.77**	**38.29**
27-Nov	N_0	34.79	35.75	33.70	35.07	**34.83**
	N_{30}	36.08	37.17	34.55	37.01	**36.20**
	N_{60}	38.55	39.81	35.04	39.49	**38.22**
	N_{90}	39.86	40.20	38.46	40.00	**39.63**
	MEAN	**37.32**	**38.23**	**35.44**	**37.89**	**37.22**
OVER ALL MEAN		**37.72**	**38.89**	**36.08**	**38.33**	

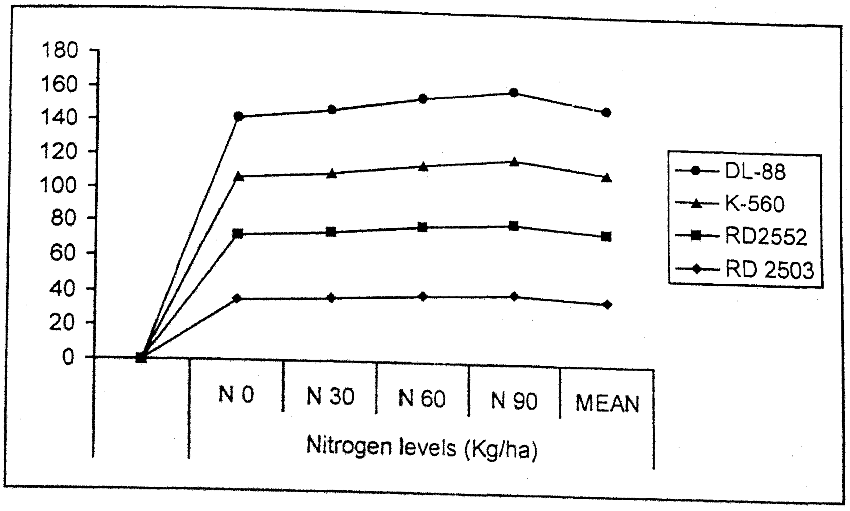
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	35.32	36.64	38.65	40.27	**37.72**
RD2552	36.74	37.75	40.37	40.69	**38.89**
K-560	34.09	35.12	36.16	38.96	**36.08**
DL-88	35.84	37.24	39.73	40.51	**38.33**

Date of sowing	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	36.17	37.18	39.24	40.59	**38.29**
27 NOV.	34.83	36.20	38.22	39.63	**37.22**
MEAN	**35.50**	**36.69**	**38.73**	**40.11**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.35	0.39	0.78	0.39	0.79	0.56	0.72
C.D. 5%	0.87	0.90	N.S.	0.79	N.S.	N.S.	N.S.

Graph-4.70 Harvest index (%) as influenced by various treatments and their inateraction (I year)





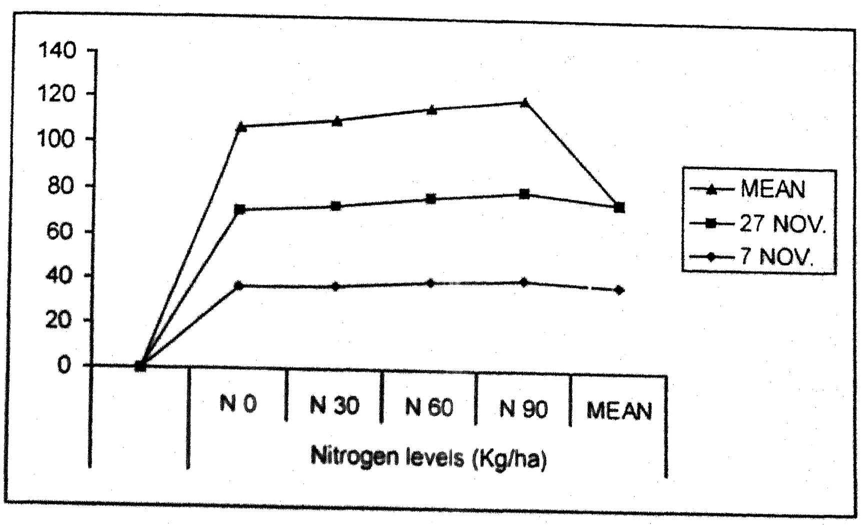


Table 4.71 Harvest index (%) as influenced by various treatments and their interaction (II year).

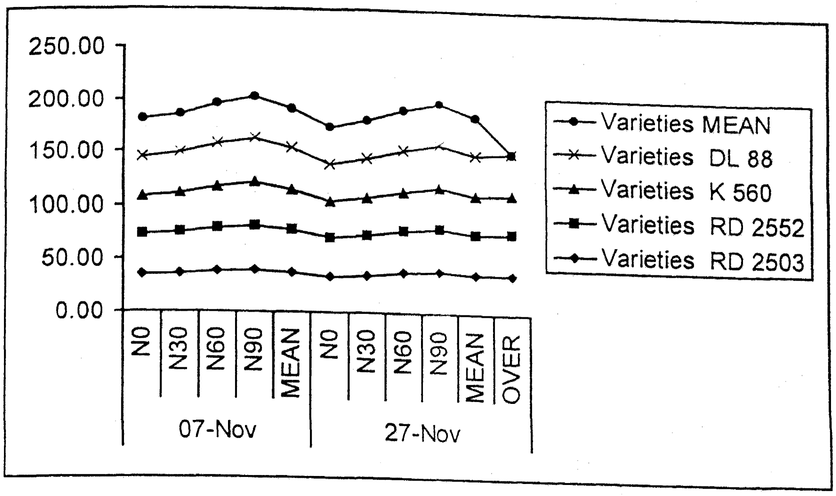
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	35.81	37.20	35.26	36.99	**36.31**
	N_{30}	37.33	38.76	36.84	38.51	**37.86**
	N_{60}	39.03	41.04	37.64	39.90	**39.40**
	N_{90}	40.59	41.32	39.45	41.29	**40.66**
	MEAN	**38.19**	**39.58**	**37.30**	**39.17**	**38.56**
27-Nov	N_0	34.78	36.28	34.53	35.84	**35.36**
	N_{30}	36.43	36.52	36.26	36.46	**36.42**
	N_{60}	39.07	40.26	36.81	39.50	**38.91**
	N_{90}	39.12	41.20	38.24	40.87	**39.86**
	MEAN	**37.35**	**38.56**	**36.46**	**38.17**	**37.63**
OVER ALL MEAN		**37.77**	**39.07**	**36.88**	**38.67**	

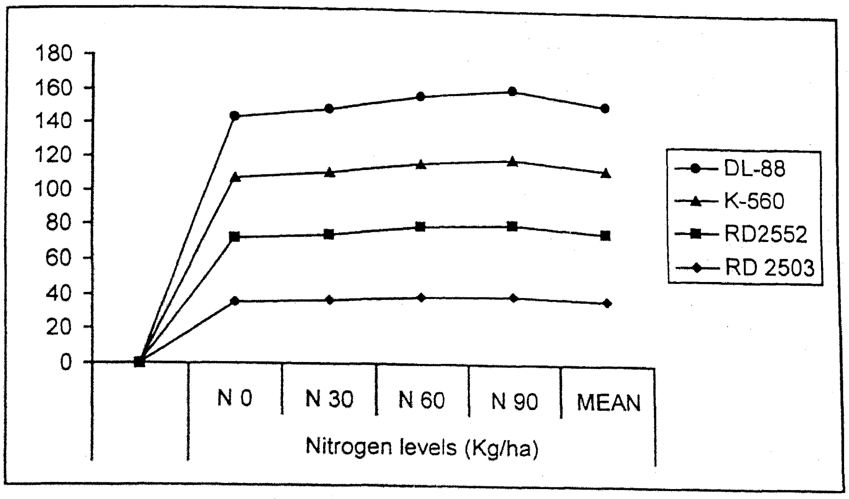
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	35.29	36.88	39.05	39.85	**37.77**
RD2552	36.74	37.64	40.65	41.26	**39.07**
K-560	34.89	36.55	37.22	38.84	**36.88**
DL-88	36.41	37.48	39.70	41.08	**38.67**

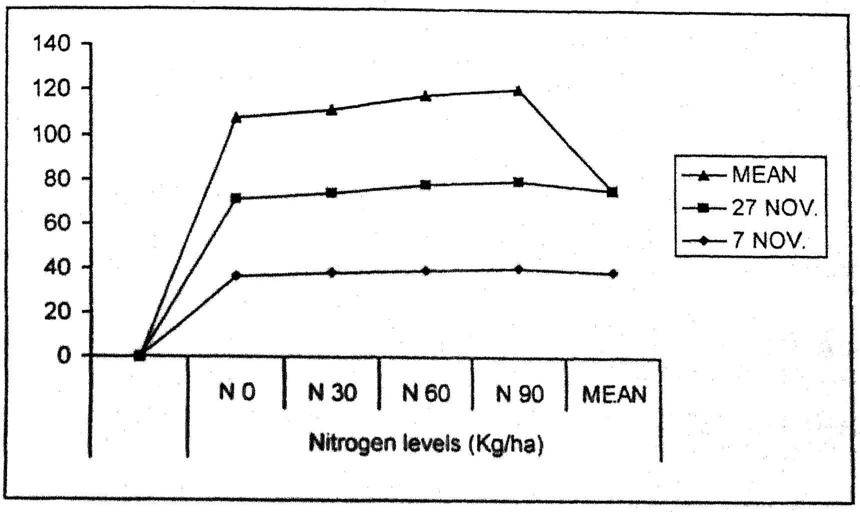
Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	36.31	37.86	39.40	40.66	**38.56**
27 NOV.	35.36	36.42	38.91	39.86	**37.63**
MEAN	**36.33**	**37.14**	**39.15**	**40.26**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em(.) ±	0.44	0.28	0.56	0.45	0.91	0.64	0.62
C.D. 5%	1.09	0.65	N.S.	0.91	N.S.	N.S.	N.S.

Graph-4.71 Harvest index (%) as influenced by various treatments and their inateraction (II year)







38.67 to 39.07% in second year). The lowest HI was found in variety K 560 (36.08 and 36.88% in the respective years.) The HI in late sown crop was significantly lower over the normal sown crop, the value being 37.22 and 37.63% in respective years. In case of normal sown crop, the value was 38.29 and 38.56% in both the years. Increasing levels of nitrogen upto N_{90} increased the HI significantly. Thus, the highest HI at N_{90} was 40.11% in first year and 40.26% in second year. However, at No (control), the HI was quite lower (35.50% in first year and 36.33% in second year). None of the treatment interaction were significant in any of the years.

4.3.4 Net return per hectare :

The data on net return was calculated estimated treatment wise and the results so obtained are presented for both the years in Table 4.72 and 4.73. The highest net return was estimated to be Rs. 16,364 and Rs. 17,095/ha from variety RD 2552. This was followed by DL88 (Rs. 14991 and Rs. 15976/ha in the respective years) and then RD 2503 (Rs. 14,8182 and 14,625/ha.) and the lowest net income (Rs. 11,116 and Rs. 12,138/ha) was estimated in variety K 560. Late sowing by 20 days (27 November) gave the lower net return (Rs. 13,335 and 14,184/ha in the respective years) as compared to the normal sown crop (Rs. 15,016 and Rs. 15,732/ha). Increasing levels of nitrogen upto N_{90} increased the

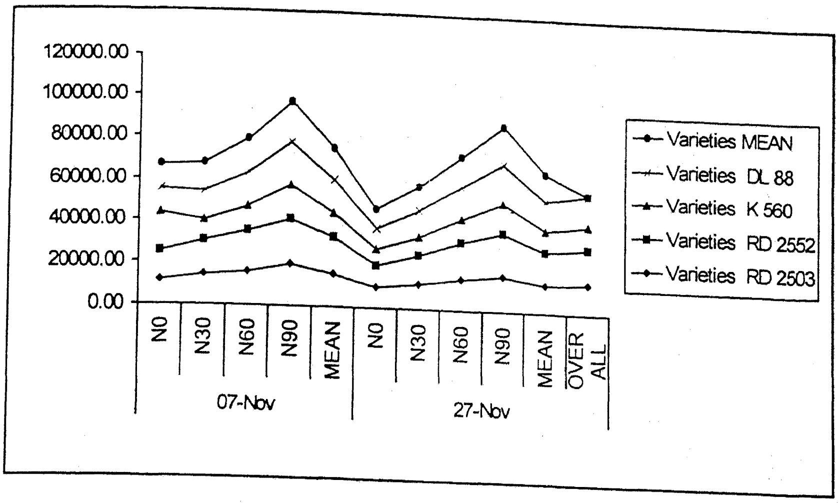
Table 4.72 Net return (Rs./ha.) as influenced by various treatments and their interaction (I year).

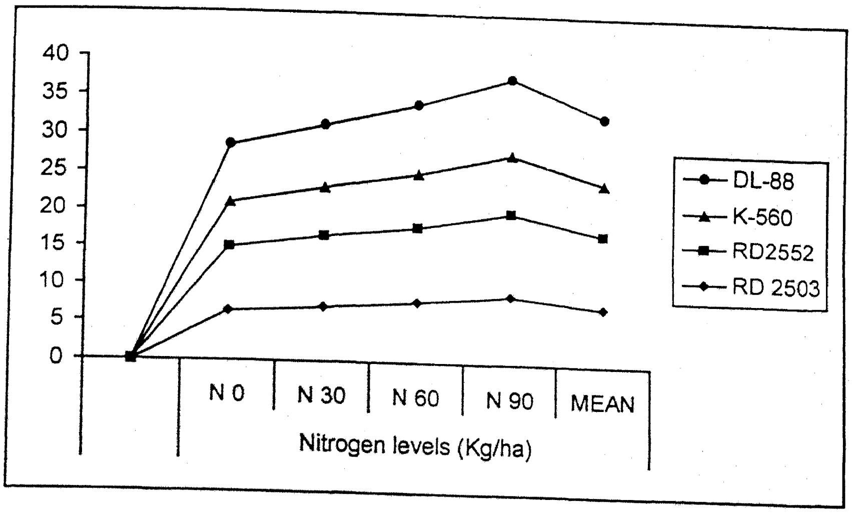
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	11209.00	13607.00	18472.00	11804.00	**11273.00**
	N_{30}	13954.00	15944.00	10075.00	14172.00	**13536.00**
	N_{60}	15783.00	19163.00	11735.00	16631.00	**15828.00**
	N_{90}	19642.00	21280.00	16570.00	20217.00	**19427.00**
	MEAN	**15147.00**	**17498.00**	**11713.00**	**15706.00**	**15016.00**
27-Nov	N_0	9875.00	10035.00	7712.00	9730.00	**9338.00**
	N_{30}	11688.00	13382.00	8865.00	12832.00	**11692.00**
	N_{60}	14626.00	17454.00	10935.00	15570.00	**14646.00**
	N_{90}	16681.00	20053.00	14966.00	18972.00	**17668.00**
	MEAN	**13217.00**	**15231.00**	**10619.00**	**14276.00**	**13336.00**
	OVER ALL MEAN	**14182.00**	**16364.00**	**11166.00**	**14991.00**	

Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	10542.00	12821.00	15204.00	18161.00	**14182.00**
RD2552	11821.00	14663.00	18308.00	20666.00	**16364.00**
K-560	8092.00	9470.00	11335.00	15768.00	**11166.00**
DL-88	10767.00	13502.00	16100.00	19594.00	**14991.00**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	11273.00	13536.00	15828.00	19427.00	**15016.00**
27 NOV.	9338.00	11691.00	14646.00	17668.00	**13336.00**
MEAN	**10305.00**	**12613.00**	**15237.00**	**18547.00**	

Graph-4.72 **Net return (Rs./ha.) as influenced by various treatments and their inateraction (I year)**





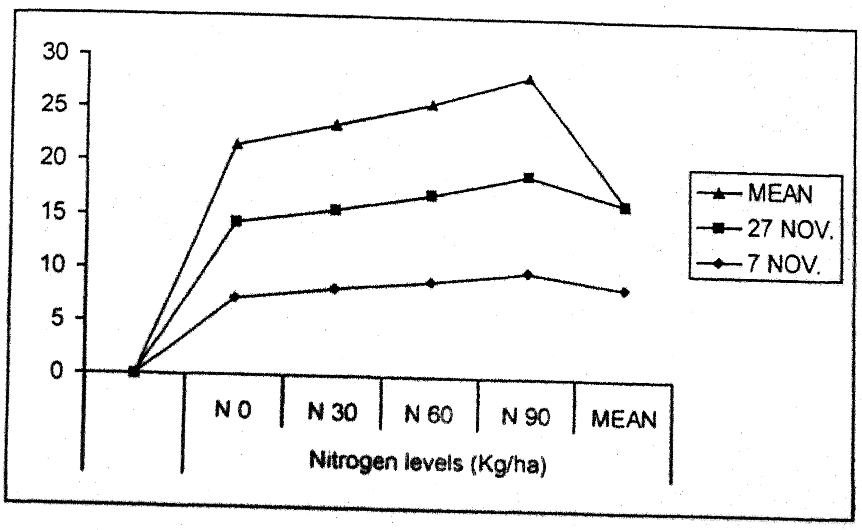


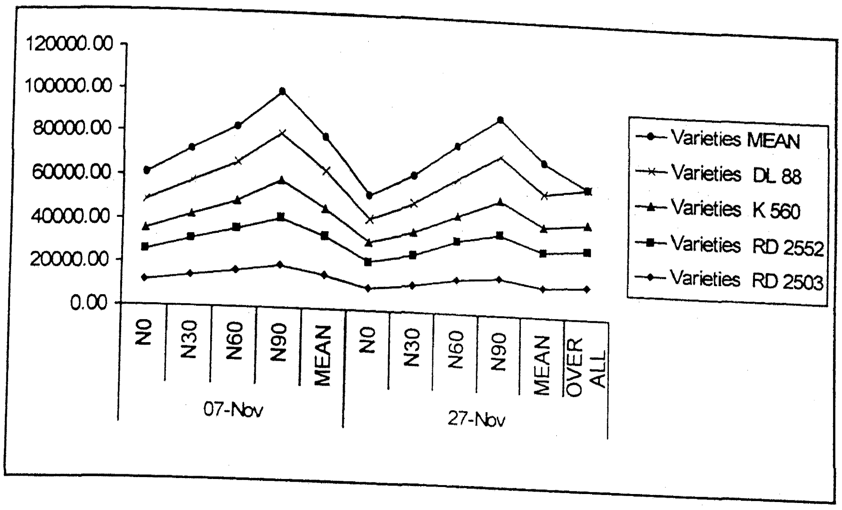
Table 4.73 Net return (Rs./ha.) as influenced by various treatments and their interaction (II year).

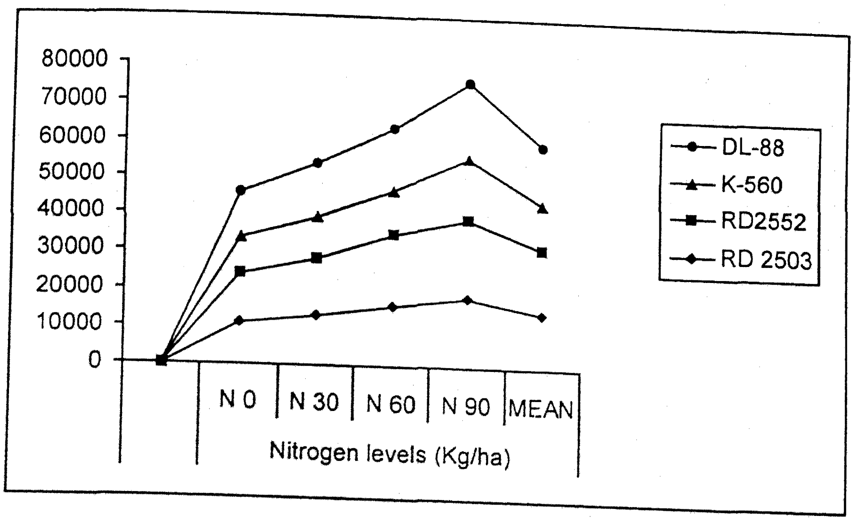
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	11554.00	14051.00	9999.00	12976.00	**12145.00**
	N_{30}	14326.00	16563.00	11202.00	15377.00	**14367.00**
	N_{60}	16507.00	19672.00	12262.00	17619.00	**16515.00**
	N_{90}	19645.00	21635.00	17169.00	21165.00	**19903.00**
	MEAN	**15508.00**	**17980.00**	**12658.00**	**16784.00**	**15732.00**
27-Nov	N_0	10332.00	12224.00	8818.00	11051.00	**10606.00**
	N_{30}	12192.00	13901.00	10621.00	13371.00	**12521.00**
	N_{60}	15382.00	18262.00	11353.00	16708.00	**15426.00**
	N_{90}	17066.00	20454.00	15677.00	19539.00	**18184.00**
	MEAN	**13743.00**	**16210.00**	**11617.00**	**15167.00**	**14184.00**
	OVER ALL MEAN	**14625.00**	**17095.00**	**12138.00**	**15976.00**	

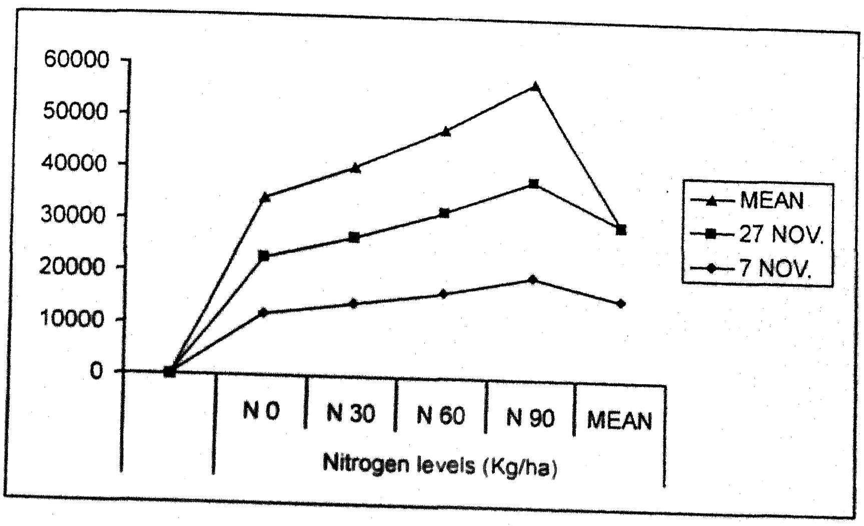
Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	10943.00	13259.00	15944.00	18355.00	**14625.00**
RD2552	13137.00	15232.00	18967.00	21044.00	**17095.00**
K-560	9408.00	10911.00	11807.00	16423.00	**12138.00**
DL-88	12013.00	14374.00	17163.00	20352.00	**15976.00**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	12145.00	14367.00	16515.00	19903.00	**15732.00**
27 NOV.	10606.00	12521.00	15426.00	18184.00	**14184.00**
MEAN	**11375.00**	**13444.00**	**15970.00**	**19043.00**	

Graph-4.73 **Net return (Rs./ha.) as influenced by various treatments and their inateraction (II year)**







net return considerably. Accordingly, the highest net retrun upto Rs. 18,547/ha) in first year and Rs. 19,043/ha in second year was obtained at the highest level of nitrogen (N_{90}). However, the lowest net return (Rs. 10,305 and Rs. 11,375/ha) was recorded in case of no nitrogen (N_0). The treatment interactions further augmented the net return considerably. The combination of best treatments were RD 2552 sown at normal date and applied with highest N level (N_{90}). This combination recorded the highest net return upto Rs. 21,280/ha in the first year and Rs. 21,635/ha in the second year. The interaction RD 2552 with N_{90} also gave the maximum net return. (Rs. 20,666 and Rs. 21,044 in the respective years) over the remaining interactions. Similarly, normal sowing date (8 November) with N_{90} also recorded higher net return (Rs. 19,427 and Rs. 19,903/ha in respective years) over rest of the treatment interactions.

4.3.5 Benefit : cost ratio :

The B.C. ratio was found to deviate in accordance with the net return obtained under various treatments and the treatment interactions. The data so obtained are presented in Table 4.74 and 4.75. The B:C ratio was highest in case of variety RD 2552 (1.78 and 1.82 in both the years). This was followed by DL88 (1.62 and 1.64 in the respective years). RD 2503 attained the third place in this respect and the last variety was K 560 giving the lowest

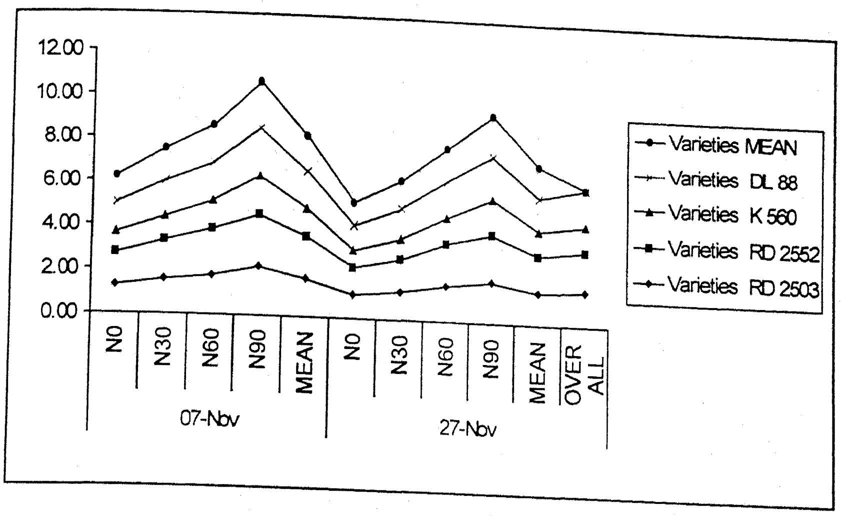
Table 4.74 Benefit : cost ratio as influenced by various treatments and their interaction (I year).

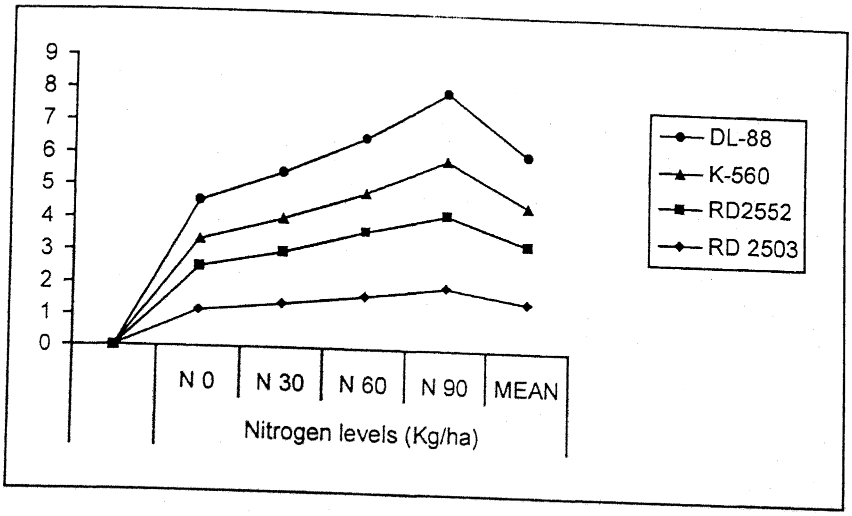
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
07-Nov	N_0	1.24	1.48	0.91	1.32	**1.24**
	N_{30}	1.55	1.75	1.08	1.59	**1.49**
	N_{60}	1.75	2.09	1.25	1.78	**1.72**
	N_{90}	2.18	2.32	1.77	2.23	**2.12**
	MEAN	**1.68**	**1.91**	**1.25**	**1.73**	**1.64**
27-Nov	N_0	1.08	1.18	0.82	1.09	**1.04**
	N_{30}	1.28	1.44	0.94	1.34	**1.25**
	N_{60}	1.61	1.88	1.16	1.65	**1.57**
	N_{90}	1.83	2.16	1.59	1.98	**1.89**
	MEAN	**1.45**	**1.64**	**1.13**	**1.51**	**1.44**
OVER ALL MEAN		**1.56**	**1.78**	**1.19**	**1.62**	

Varieties	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
RD 2503	1.16	1.41	1.68	2.00	**1.56**
RD2552	1.33	1.59	1.98	2.24	**1.78**
K-560	0.86	1.01	1.20	1.68	**1.19**
DL-88	1.20	1.46	1.71	2.10	**1.62**

Date of sowing	Nitrogen levels (Kg/ha) N_0	N_{30}	N_{60}	N_{90}	MEAN
7 NOV.	1.24	1.49	1.72	2.12	**1.64**
27 NOV.	1.04	1.25	1.57	1.89	**1.44**
MEAN	**1.14**	**1.37**	**1.64**	**2.00**	

Graph-4.74 **Benefit : cost ratio as influenced by various treatments and their inateraction (I year)**





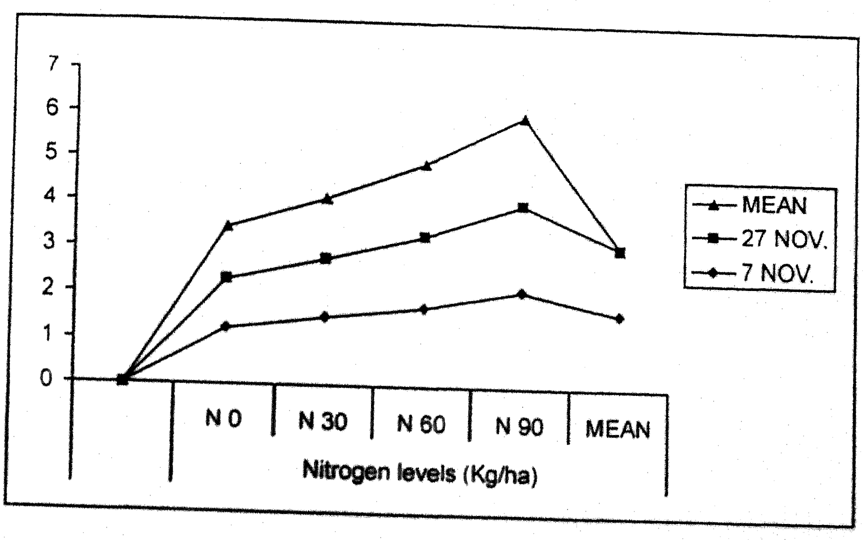


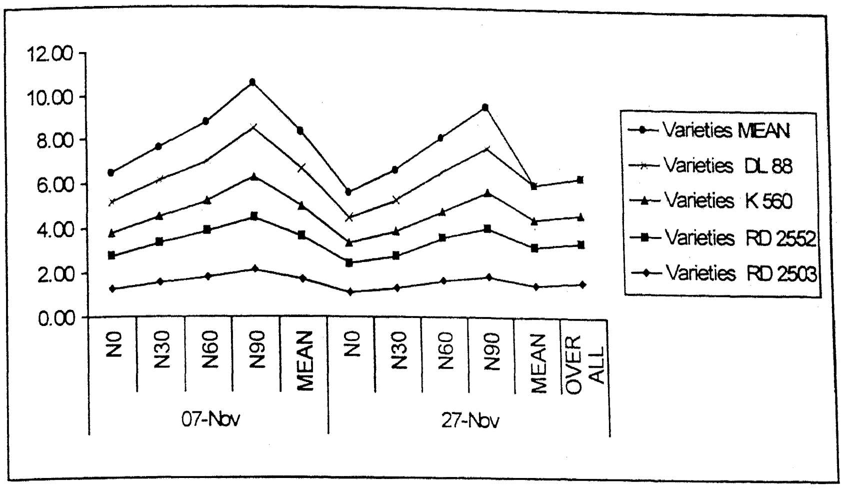
Table 4.75 Benefit : cost ratio as influenced by various treatments and their interaction (II year).

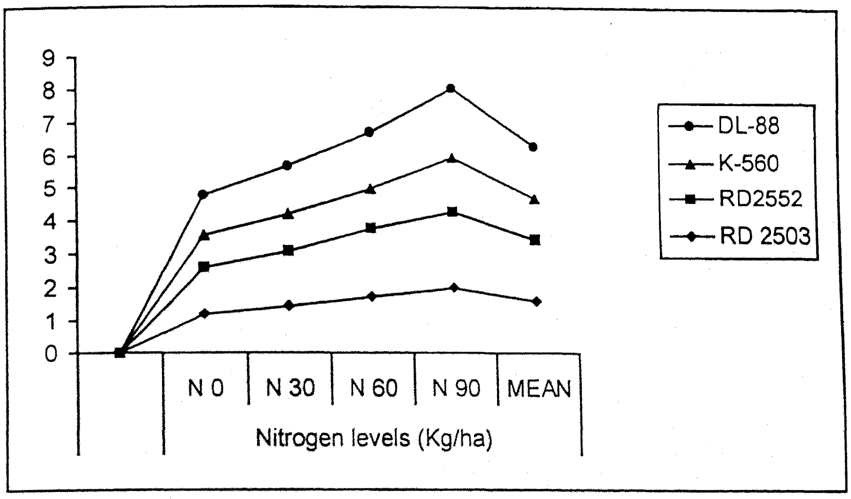
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	1.26	1.50	1.05	1.34	1.29
	N_{30}	1.56	1.77	1.18	1.59	1.52
	N_{60}	1.80	2.11	1.29	1.82	1.75
	N_{90}	2.14	2.35	1.80	2.19	2.12
	MEAN	1.69	1.93	1.33	1.73	1.67
27-Nov	N_0	1.11	1.30	0.92	1.13	1.11
	N_{30}	1.32	1.47	1.11	1.37	1.32
	N_{60}	1.66	1.94	1.18	1.71	1.62
	N_{90}	1.84	2.17	1.63	2.00	1.91
	MEAN	**1.48**	**1.72**	**1.21**	**1.55**	
OVER ALL MEAN		**1.59**	**1.82**	**1.27**	**1.64**	

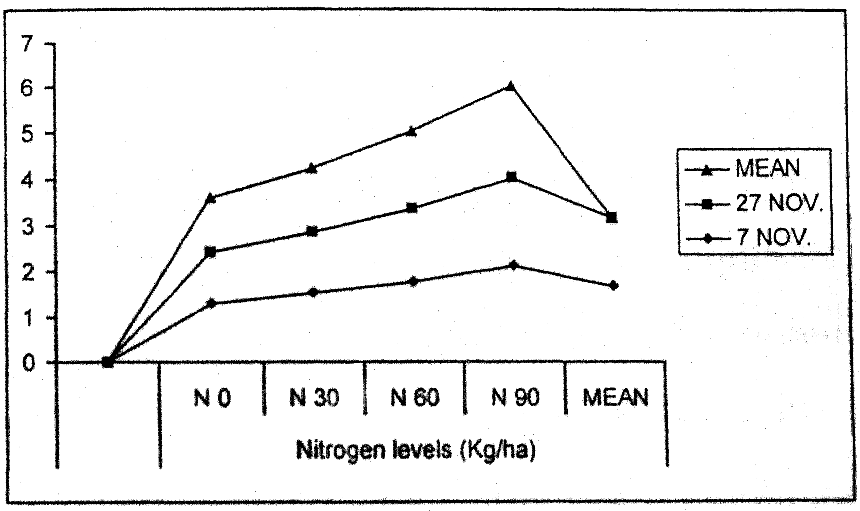
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	1.18	1.44	1.73	1.99	1.59
RD2552	1.40	1.62	2.02	2.26	1.82
K-560	0.98	1.14	1.23	1.71	1.27
DL-88	1.23	1.48	1.76	2.09	1.64

Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	1.29	1.52	1.75	2.12	1.67
27 NOV.	1.11	1.32	1.62	1.91	1.49
MEAN	**1.20**	**1.42**	**1.68**	**2.01**	

Graph-4.75 **Benefit : cost ratio as influenced by various treatments and their inateraction (II year)**







B:C ratio (1.19 and 1.27 in the respective years). Late sowing brought down the B:C ratio considerably (1.44 and 1.49) as against the normal sowing (1.64 and 1.67) in the respective years. Increasing nitrogen levels upto N_{90} increased the B:C ratio. Accordingly, the highest B:C ratio was 2.0 in first year and 2.01 in the second year at the highest nitrogen level (N_{90}). However, the lowest B:C ratio was only 1.14 and 1.20 in the respective years in case of no nitrogen (No). Among the treatment interactions, the highest B:C ratio went upto 2.32 and 2.35 in the respective years when RD 2552 sown on the normal date and applied with highest N level (N_{90}). Similarly, when RD 2552 either sown on the normal date or applied with highest N-level (N_{90}) resulted with highest B:C ratios. Normal date with N_{90} also gave the best interactions results over the other interactions.

4.4 Grain quality :

4.4.1 Protein in grain :

The grain protein was found to influence significantly due to various treatments and their interaction in both the years as revealed from Table 4.76 and 4.77. The protein content was significantly higher (12.58-12.63%) in K 560 over rest of the varieties. However, RD 2552 attained second postion (11.92-12.10%), followed by DL 88 (11.51-11.55%). The lowest grain protein (10.50-10.55%) was recorded in case of RD 2503.

Table 4.76 Protein content of seed as influenced by various treatments and their interaction (I year).

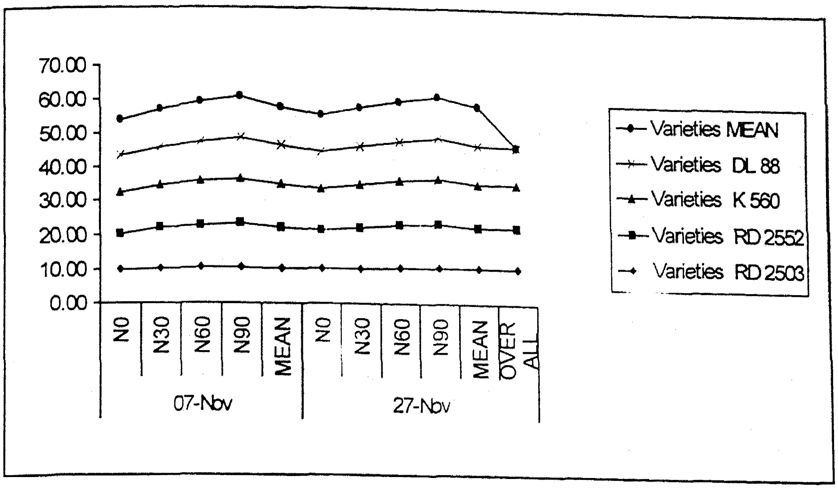
Date of sowing	Nitrogen levels (Kg/ha)	Varieties				MEAN
		RD 2503	RD 2552	K 560	DL 88	
07-Nov	N_0	10.18	10.37	11.81	10.92	**10.82**
	N_{30}	10.36	11.81	12.42	11.20	**11.45**
	N_{60}	10.74	12.18	12.88	11.63	**11.86**
	N_{90}	10.78	12.75	13.00	12.22	**12.19**
	MEAN	**10.51**	**11.78**	**12.53**	**11.49**	**11.58**
27-Nov	N_0	10.28	11.37	11.95	10.90	**11.12**
	N_{30}	10.51	11.80	12.51	11.28	**11.52**
	N_{60}	10.80	12.28	13.02	11.62	**11.93**
	N_{90}	10.75	12.80	13.05	12.35	**12.24**
	MEAN	**10.58**	**12.06**	**12.63**	**11.54**	**11.70**
	OVER ALL MEAN	**10.55**	**11.92**	**12.58**	**11.51**	

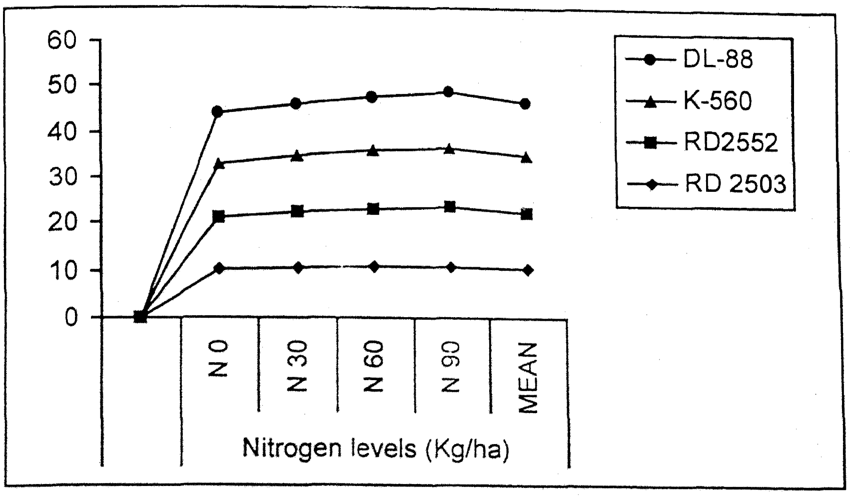
Varieties	Nitrogen levels (Kg/ha)				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
RD 2503	10.23	10.43	10.77	10.76	**10.55**
RD2552	10.87	11.80	12.23	12.77	**11.92**
K-560	11.88	1246.00	12.95	13.02	**12.58**
DL-88	10.91	11.24	11.62	12.28	**11.51**

Date of sowing	**Nitrogen levels (Kg/ha)**				
	N_0	N_{30}	N_{60}	N_{90}	**MEAN**
7 NOV.	11.82	11.45	11.86	12.19	**11.58**
27 NOV.	11.12	11.52	11.93	12.24	**11.70**
MEAN	**11.47**	**11.48**	**11.89**	**12.21**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Em. ±	0.007	0.01	0.02	0.01	0.02	0.02	0.02
C.D. 5%	0.02	0.03	0.05	0.02	0.05	N.S.	0.04

Graph-4.76 **Protein content of seed as influenced by various treatments and their inateraction (I year)**





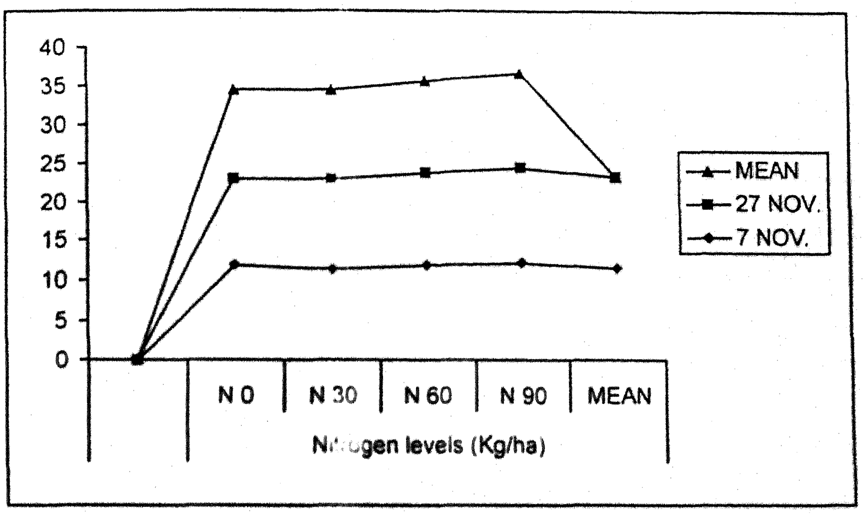


Table 4.77 Protein content of seed as influenced by various treatments and their interaction (II year).

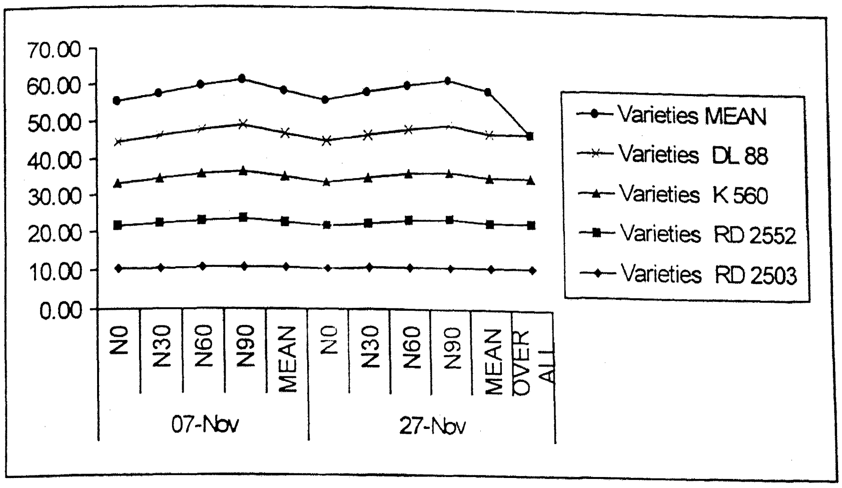
Date of sowing	Nitrogen levels (Kg/ha)	RD 2503	RD 2552	K 560	DL 88	MEAN
		Varieties				
07-Nov	N_0	10.21	11.42	11.87	10.96	**11.11**
	N_{30}	10.40	11.86	12.46	11.22	**11.48**
	N_{60}	10.76	12.24	12.92	11.68	**11.90**
	N_{90}	10.82	12.76	13.06	12.25	**12.22**
	MEAN	**10.55**	**12.07**	**12.58**	**11.53**	**11.68**
27-Nov	N_0	10.33	11.38	11.99	10.94	**11.16**
	N_{30}	10.57	11.92	12.58	11.31	**11.59**
	N_{60}	10.84	12.36	13.07	11.69	**11.99**
	N_{90}	10.83	12.83	13.11	12.38	**12.29**
	MEAN	**10.64**	**12.12**	**12.69**	**11.58**	**11.76**
OVER ALL MEAN		**10.60**	**12.10**	**12.63**	**11.55**	

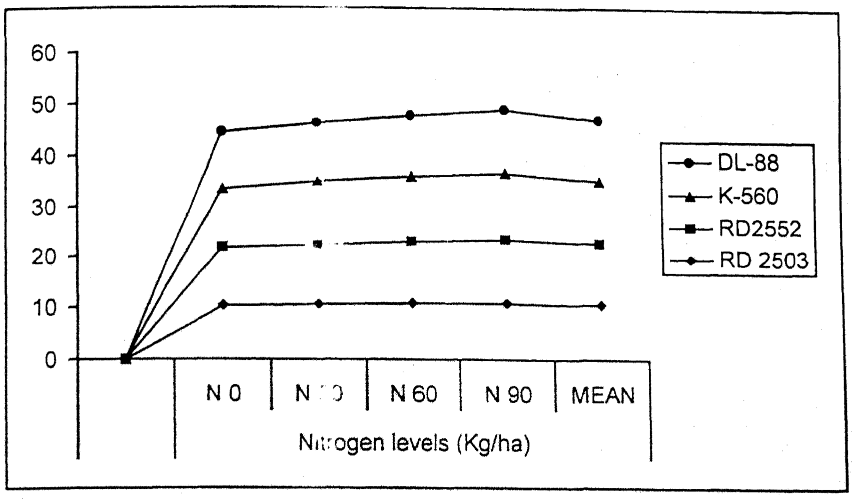
Varieties	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
RD 2503	10.27	10.48	10.80	10.82	**10.60**
RD2552	11.40	11.89	12.30	12.79	**12.10**
K-560	11.93	12.52	12.99	13.08	**12.63**
DL-88	10.95	11.26	11.68	12.31	**11.55**

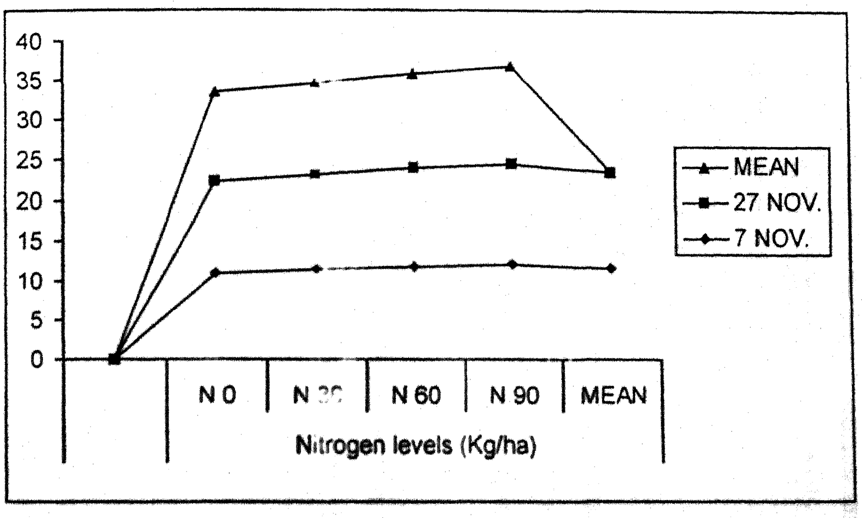
Date of sowing	N_0	N_{30}	N_{60}	N_{90}	MEAN
	Nitrogen levels (Kg/ha)				
7 NOV.	11.11	11.48	11.90	12.22	**11.68**
27 NOV.	11.16	11.59	11.99	12.29	**11.76**
MEAN	**11.13**	**1153.00**	**11.94**	**12.25**	

	V	D	V x D	N	V x N	D x N	V x D x N
S.Emt. ±	0.01	0.003	0.01	0.01	0.01	0.01	0.01
C.D. 5%	2.00	0.01	0.01	0.01	0.03	0.02	0.02

Graph-4.77 **Protein content of seed as influenced by various treatments and their inateraction (II year)**







Summary table -4.78

Yield attributes at a glance - (b)

Treatments	Yield attributes as influnced by different treatments																	
Main plot treatments	Grain Yield (q/ha)			Straw Yield (q/ha)			Harvest index (%)			Net Income			Benefit Ratio Benefit Cost ratio			Protien Conten Seed% (%)		
Varieties	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**	**I Year**	**II Year**	**Mean**
V_1	36.82	37.76	**37.29**	60.45	62.11	**61.28**	37.72	37.77	**37.74**	14182	14625	**14403**	1.56	1.59	**1.57**	10.55	10.60	10.58
V_2	40.95	42.45	**41.70**	63.93	65.70	**64.81**	38.89	39.07	**38.98**	16364	17095	**16729**	1.78	1.82	**1.80**	11.92	12.10	12.01
V_3	32.13	34.07	**33.10**	56.07	57.98	**57.02**	36.08	36.88	**36.48**	11166	12138	**11652**	1.19	1.27	**1.23**	12.58	12.63	12.61
V_4	39.07	41.04	**40.05**	62.49	64.40	**63.44**	38.33	38.67	**38.50**	14991	15976	**15483**	1.62	1.64	**1.63**	11.51	11.55	11.53
C.D.(5%)	1.33	1.40	**1.36**	3.05	3.46	**3.25**	0.87	1.09	**0.98**							0.02	0.02	0.02
Sub plot treat.																		
Date of sowing																		
D_1	38.66	40.14	**39.40**	61.86	63.49	**62.67**	38.29	38.56	**38.42**	15016	15732	**15374**	1.64	1.67	**1.65**	11.58	11.68	11.63
D_2	35.82	37.51	**36.66**	59.61	61.60	**60.60**	37.22	37.63	**37.42**	13335	14184	**13759**	1.44	1.49	**1.46**	11.70	11.76	11.73
C.D.(5%)	0.63	0.60	**0.61**	2.42	1.91	**2.16**	0.90	0.65	**0.77**							0.03	0.01	0.02
Sub-subplot treat																		
N-levels (Kg/ha.)																		
N_1	30.40	32.43	**31.41**	55.10	57.79	**56.44**	35.50	36.33	**35.91**	10305	11375	**10840**	1.14	1.20	**1.17**	11.47	11.13	11.30
N_2	34.34	36.05	**35.19**	59.33	61.02	**60.17**	36.69	37.14	**36.91**	12613	13444	**13028**	1.37	1.42	**1.39**	11.52	11.53	11.53
N_3	39.26	40.77	**40.01**	61.36	63.07	**62.21**	38.73	39.15	**38.94**	15237	15970	**15603**	1.64	1.68	**1.66**	11.89	11.94	11.92
N_4	44.96	46.05	**45.50**	67.16	68.30	**67.73**	40.11	40.26	**40.18**	18547	19043	**18795**	2.00	2.01	**2.00**	12.21	12.25	12.23
C.D.(5%)	0.91	1.20	**1.05**	2.58	1.90	**2.24**	0.79	0.91	**0.85**							0.03	0.01	0.02
Interaction																		
VxD	N.S.	N.S		N.S.	N.S.		N.S.	N.S.								0.05	0.01	0.04
VxN	1.83	N.S		N.S.	N.S.		N.S.	N.S.								0.05	3.00	0.04
DxN	N.S.	N.S		N.S.	N.S.		N.S.	N.S.								N.S.	0.02	0.01
VxDxN	N.S.	N.S		N.S.	N.S.		N.S.	N.S.								0.04	0.02	0.03

Increasing N levels increased the seed protein significantly. As such, the highest value was 12.28-12.31% in case of N_{90}, while the lowest being 10.91-10.95% in case of No. Late sowing significantly enhanced the seed protein. The best treatment interaction was K 560 sown on 27 November and applied with N_{90} which resulted in significantly higher seed protein (13.05 to 13.11% in both the years) over all the rest of the interactions. The other interactions also performed the same way in both the years.

4.5 Correlation Studies :

The results on correlation analysis of various growth parameters and yield components with each other and grain yield of barley are presented in Table 4.79 and 4.80. The findings reveal that all these parameters had more or less positive correlation with each other and with grain yield in both the years. There was no any negative correlation. Number of tillers at 60 and 90 days stage were found to be significantly correlated with grain yield (r=0.50 and r=0.5 in 1 year and r=0.53 and r=0.54 in 2nd year). Amongst the yield components, number of functional leaves and number of spikes/plant were found to be highly correlated with the grain yield (r=0.68 to 0.74) and r=0.67 to 0.72 respectively). Spike length and plant population had no correlation with the grain yield upto the significant level.

Table 4.79 Correlation matrix (I year)

	Plant population/ running meter at 30 days	No. of tillers/ running meter at 90 days	No. of tillers/ plant at 60 days	No. of functional leaves/plant at 90 days	No. of spikes plant	Spike length (cm)	Grain yield (q/ha)
Plant population/ running meter at 30 days	1.00	0.75	0.53	0.26	0.21	0.65	0.22
No. of tillers/ running meter a 90 days		1.00	0.90	0.45	0.51	0.75	0.50**
No. of tillers/ plant at 60 days			1.00	0.41	0.60	0.66	0.51**
No. of functional leaves/plnat at 90 days				1.00	0.58	0.29	0.68**
No. of spikes/ plnat					1.00	0.38	0.72**
Spike length (cm)						1.00	0.36
Grain yield (q/ha)							1.00

No need to show this figure

** Highly significant at 1%

Graph-4.78 **Correlation matrix (I year)**

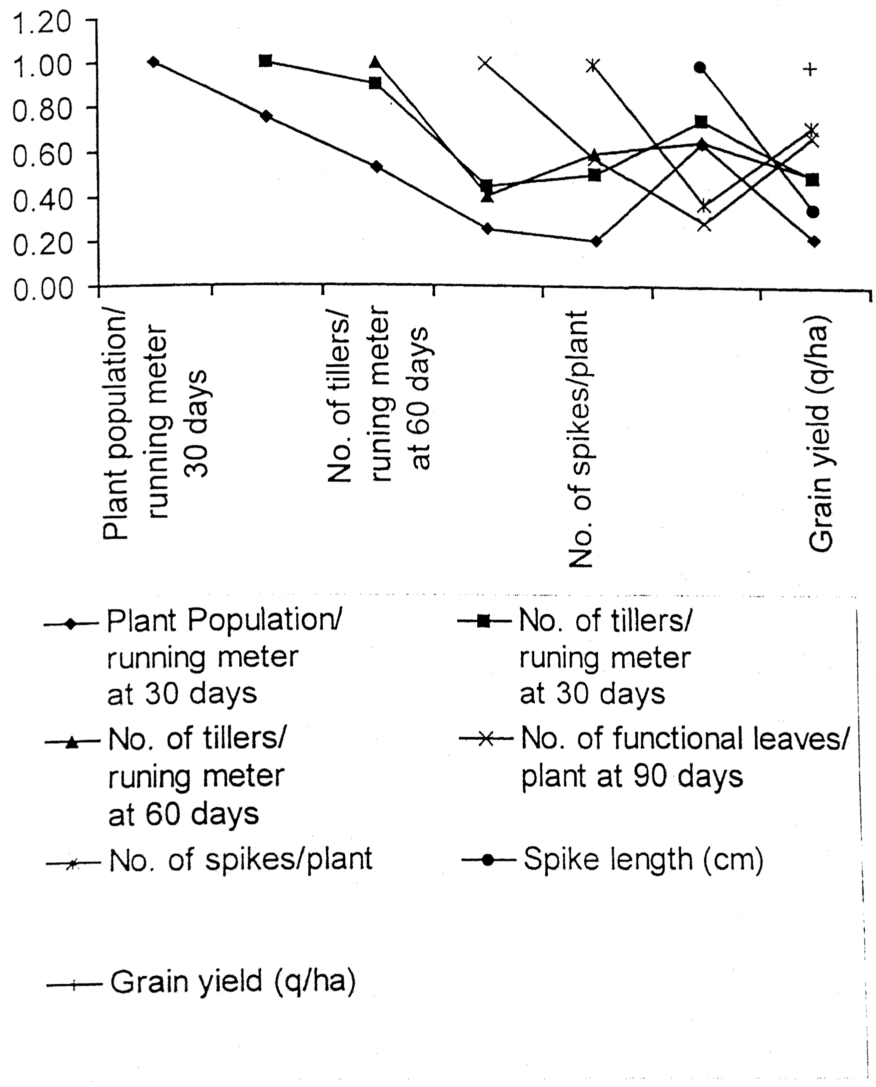


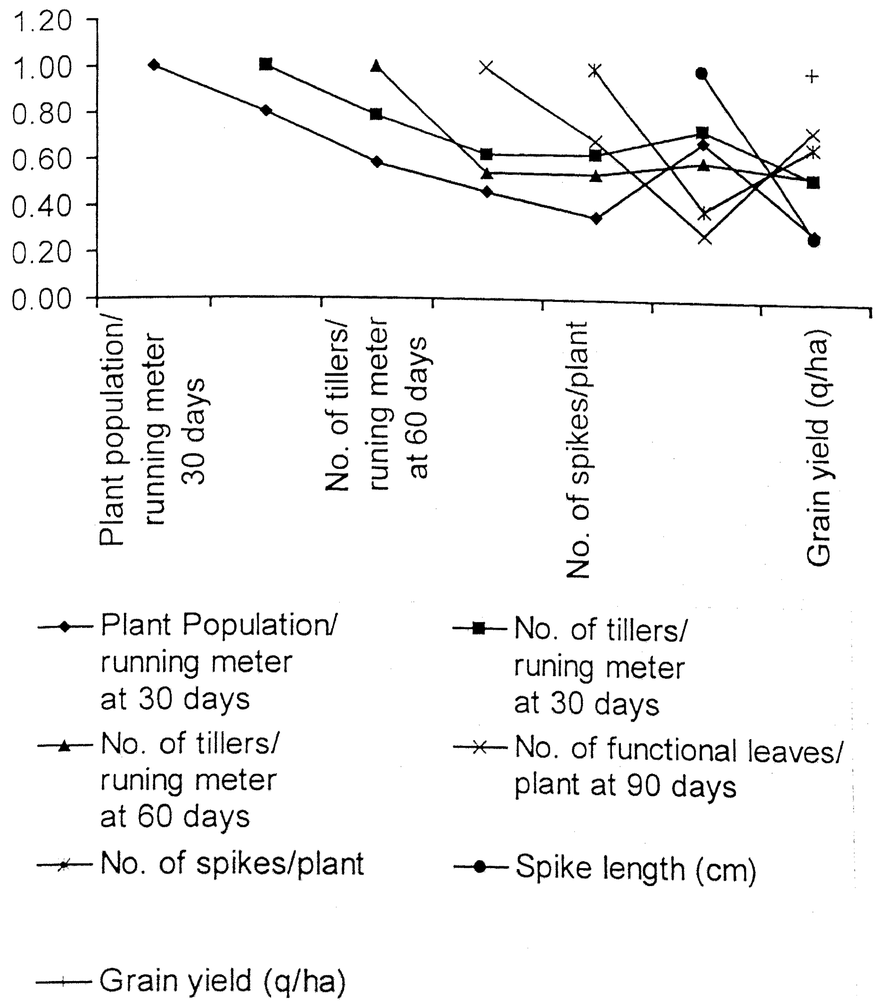
Table 4.80 Correlation matrix (II year)

	Plant population/ running meter at 30 days	No. of tillers/ running meter at 90 days	No. of tillers/ plant at 60 days	No. of functional leaves/plant at 90 days	No. of spikes/ plant	Spike length (cm)	Grain yield (q/ha)
Plant population/ running meter at 30 days	1.00	0.80	0.58	0.46	0.36	0.69	0.30
No. of tillers/ running meter a 90 days		1.00	0.79	0.62	0.63	0.74	0.53**
No. of tillers/ plant at 60 days			1.00	0.54	0.54	0.60	0.54**
No. of functional leaves/plnat at 90 days				1.00	0.69	0.29	0.74**
No. of spikes/ plnat					1.00	0.39	0.67**
Spike length (cm)						1.00	0.28
Grain yield (q/ha)							1.00

** Highly significant at 1%

Not needed

Graph-4.79 Correlation matrix (II year)



DISCUSSION

DISCUSSION

The significant findings of the present investigation have been interpretted and discussed in this chapter in the light of the research work carried out by the agricultural scientists in our country and abroad. The discussion comprises the relevant topics viz. growth and physiological parameters, and yield attributes quantitative (grain and straw yield), qualitative parameters grain protein as well as net return per hectare.

5.1 Weather conditions :

Rainfall pattern (quantum, intensity and distribution), temperature, light (sun shine hours) and humidity during the crop growth period, are the major weather components, influencing the crop and its economic yield. Barley, being a *rabi* (winter) season crop, rainfall particularly winter rains and prevailing temperature, light intensity and humidity, therefore, play an important role in the growth and development of barley plants. The meteorological data, as presented in Table 2 and 3 indicate that the weather conditions were almost congenial for the better growth and development of barley during both the seasons. years.

5.2 Plant population :

Uniform plant density is an important requisite for obtaining

higher precision when it is not a variable factor as the treatments. The data in Table 4.1 and 4.2 indicate that the plant population per metre row length has deviated significantly due to different varieties under test, sowing dates as well as increasing levels of nitrogen. Under the similar soil environmental conditions, K-560 germinated better and giving higher plant population per unit area, while RD 2503 did not do so. This variation may be due to variability in the seed viability to germinate and emerge properly in different varieties. Late sowing discouraged the desired plant population owing to unfavourable soil enviornment persisted under 20 days late sown conditions. However, increasing levels of nitrogen encouraged this parameter on account of beneficial effect due to increased nitrogen nutrititon available to the emerging and growing seedlings.

5.3 Vegetative growth characters :

The plant height and dry weight/plant were ~~was~~, in general enhanced by multifold with the enhancement of plant growth and development in successive stages upto maturity stage. However, the fresh weight/plant and leaf area index were enhanced only upto 90 days stage of crop observation in case of fresh weight, abrupt multifold rise was observed between 60 and 90 days stages of growth. The decrease in fresh weight beyond 90 days may be on account of lack of vegetative succulence and natural desiccation associated with the advancement of plant growth and development.

The number of functional leaves/pland and tillers per meter row length were increased only upto 60 days stage of growth, thereafter a decline was noticed in these characters. This may be due to leaf-senescence and leaf fall and dryness of tillers as the plants started going towards advanced growth and reproductive phases.

In addition to above observations, some interesting features (result-trends) emerged up with respect to morpho-physiological parameters in different barley genotypes grown under normal and late sowing dates as well as with different levels of nitrogen. The variety K 560 proved the tallest one at every stage, followed by DL 88, while RD 2503 was found the dwarfest one. In case of number of tillers/m row length as well as per plant, the variety RD 2552 proved the best at every stage. This was, however followed by K 560 and DL 88. The variety RD 2503 gave the lowest tiller number at every stage. The other four characters viz. functional leaves/plant, leaf area index, fresh and dry weight/plant were found highest in variety RD 2552, followed by DL 88 and the RD 2503, the lowest being in case of K 560 at every stage of plant growth. These variations in growth and development characters may be on account of genetic variability among the genotypes which were obtained from different origins (cross-breedings).

The variations in growth characters (height and tillers) in different barley genotypes have been reported by several research workers at different Research Stations in India (Singh, 1982; Singh *et al.*, 1985; Raikwar and Paradkar, 1987; Dwivedi *et al.*, 1987; Verma and Singh, 1989; Sharma and Chakravarty, 1992; Awasthi *et al.*, 1993; Patel and Namdeo, 1996; Tomar, 1998; Baishandar, 2002).

In comparision to normal sowing late sowing by 20 days (27 November), discouraged significantly all the growth and development characters at every stage of crop growth. This may be due to curtailment in the most active vegetative growth period on account of 20 days late sowing. Similar results on account of delayed sowing have been obtained at several places in India (Phadnawis and Saini, 1986; Bagga *et al.*, 1987; Sarkar *et al.*, 1987; Patel *et al.*, 1987; Girothia *et al.*, 1987; Paradkar *et al.*, 1987; Choudhary *et al.*, 1988; Samere *et al.*, 1989; Sharma and Chakor, 1989; Vitkare *et al.*, 1990; Parmar and Singh, 1990; Pandey and Agrawal, 1991; Porwal *et al.*, 1991; Naik *et al.*, 1991; Sarkar and Tarfdar, 1992; Kaurav, 1992; Jain *et al.*, 1992; Singh *et al.*, 1992; Behera, 1994; Ahuja *et al.*, 1996; Singh, 1997 and Sen, 1999).

Applied nitrogen upto 80 kg N/ha encouraged significantly the plant foliage and boosted plant growth all the characters at every stage because nitrogen is an integral part of chlorophyll, and

proteins, enzymes and structural material. Nitrogen functions as a storer of energy. It is also responsible for the dark-green colour of the leaves, vigorous growth, tillering, leaf production and enlargement of leaf surface. The significant encouragement due to applied N from 40 kg upto 80 kg/ha was obtained in all the growth and development characters observed at different intervals including total biomass production (fresh and dry weight/plant). The beneficial influence of N levels on growth and development characters has been reported by the several investigators in the country (Biswas and Singh, 1982; Singh *et al.*, 1984; Singh *et al.*, 1985; Dwivedi *et al.*, 1987; Shekhawat *et al.*, 1989; Mishra *et al.*, 1991; Porwal *et al.*, 1991; Awasthi and Suraj Bhan, 1993; Awasthi *et al.*, 1993; Patel and Namdeo, 1996; Tomar, 1998; Chakrawarti, 1999, Patel *et al.*, 2000; Tomar *et al.*, 2001).

5.4 Yield attributes :

Each plant passes through the vegetative as well as reproductive phases of growth to complete its life cycle. Economic yield can be considered to be the final expression of the physiological and metabolic activities of plants and is governed by various factors viz. adaphic, climatic, micro-environmental as well as input management factors. These yield attributing factors have direct bearing on plant productivity and for increasing the grain yield. That means, the number of spikes/plant, spike length, number of

spikelets/spike, number and weight of grains/spike and 1000 grain weight etc. play an paramount role.

As per present findings, all the above mentioned yield-attributing characters two years mean have been highlighted in summary Table 4.65. Accordingly, the spikes/plant was maximum in RD 2552, but other five characters viz. spike lenght, spikelets/ spike, grains/ spike, grain weight/spike and 1000 grain weight were maximum in variety K 560. However, the second best variety was RD 2552 with respect to all these five characters. RD 2503 gave the lowest performance in these characters. The variations in yield attributes in different varieties of barley have also been reported by several workers (Raikwar and Paradkar, 1987; Dwivedi *et al.*, 1987; Sharma and Chakrawarti, 1992; Patel and Namdeo, 1996; Fathi *et al.*, 1997; Subhash Chandra *et al.*, 1998; Chakrawarti, 1999; Patel *et al.*, 2000, Tomar *et al.*, 2001; Pandey and Singh, 2001).

Late sowing of barley varieties by 20 days (27 November) significantly decreased all the yield attributing characters. The decrease in yield attributes due to delayed sowing may be attributed to short growing period available to crop plants for their proper growth and development. These results corroborate with the findings of several workers as already mentioned earlier in vegetative growth sections 5.3.

Applied nitrogen upto 80 kg N/ha encouraged all the yield components significantly as compared to the preceding doses. This may be due to encouragement of all the vegetative growth characters due to applied N levels which consequently benefitted all the yield-attributing characters. These findings are in accordance with those of other researchers as already notified earlier in the vegetative growth section.

5.5 Grain and straw yield :

The variety RD 2552 proved to be the top yielder producing 41.70 q/ha grain and 64.81 q/ha straw the mean of both the years. The second best variety was DL 88 which yielded 40.05 and 63.44 q/ha respectively. The lowest yielder variety was K 560 producing 33.10 q/ha grain and 57.02 q/ha straw.

The main yield component the number of spikes/plant was highest in RD 2552 which attributed the highest grain yield. DL88, although stood the second best in grain yield, but the yield compoents other than spikes/plant were lower than K 560 giving the lowest grain yield. K 560 also gave the lowest straw yield which may be due to lowest vegetative growth characters including fresh and dry weight/plant in this variety. Such variations in grain and straw yield among the barley varieties may be due to genetic variability developed by the barley breeders. Such type of wider variations in grain and straw yields among the barley varieties have

been reported by the many workers (Sharma and Chakrawarti, 1992; Verma *et al.*, 1993; Awasthi *et al.*, 1993; Awasthi and Bhan, 1994; Fathi *et al.*, 1997; Subhash Chandra *et al.*, 1998; Dhukea *et al.*, 1998; Saini and Thakur, 1999, Sen 1999, Chakrawarti, 1999; Patel *et al.*, 2000; Tomar *et al.*, 2001; Pandey and Singh, 2001; Paramjit *et al.*, 2001 and Baishandar, 2002).

The grain yield and straw yield of barley varieties was significantly reduced by 2.74 and 2.07 q/ha respectively when sown 20 days late (27 November) over the normal sowing date (7 November). Such decrease in yield may be due to significant decrease in the yield - attributing characters of the late - sown crop. It is evident that the sowing of the crop should not be delayed any more beyond 7 November. Many workers in India also reported considerably reduction in grain yield of barley due to late sowing than the normal sowing date of the region (Vitkare *et al.*, 1990; Parmar and Singh, 1990; Pandey and Agrawal, 1991; Porwal *et al.*, 1991; Naik *et al.*, 1991; Sarkar and Torafdar, 1992; Kaurav, 1992; Jain, *et al.*, 1992; Singh *et al.*, 1992; Behera, 1994; Ahuja *et al.*, 1996; Singh, 1997 and Sen, 1999).

Application of 30, 60 and 90 kg N/ha significantly increased the grain yield by 3.78, 8.60 and 14.09 q/ha respectively over no nitrogen. Similarly, such increases in straw yield were 3.73, 5.77 and 11.29 q/ha due to respective applied N-levels. These

increases in grain and straw yield may be due to significant increases in vegetative growth characters and yield-attributing parameters with the increasing levels of nitrogen. The beneficianl influence of applied N-levels upon grain and straw yield of barley varieties have been obtained by many workers in different part of India (Dahama, 1991; Kumar and Agrawal, 1991; Singh, 1993; Awasthi and Suraj Bhan, 1993; Awasthi *et al.*, 1993; Sood *et al.*, 1993; Awasthi and Bhan, 1994; Patel and Namdeo, 1996; Fathi *et al.*, 1997; Subhash Chandra *et al.*, 1998; Dhukea *et al.*, 1998; Saini and Thakur, 1999; Chakrawarti, 1999; Patel *et al.*, 2000; Tomar *et al.*, 2001; Pandey and Singh, 2001, Truck and Shatanawi, 2001, Paramjit *et al.*, 2001 and Baishander, 2002).

5.6 Harvest index (HI) :

Among the varieties, the higher HI i.e. 38.50 and 38.98% was recorded in case of DL 88 and RD 2552 respectively. This was followed by RD 2503 (37.75%), and the lowest in K 560 (36.48%). The higher HI in RD 2552 and then in DL 88 may be due to increased yield attributing characters which attributed comparatively more proportion of seed formation over straw as compared to those varieties (RD 2503 and K 560) giving lower HI. Thus increased HI in such varieties must be the resultant of genetic improvement made by the barley breeders time to time.

Late sowing discouraged this parameter, while increasing N-levels encouraged it significantly. As already explained that late sowing shortened the growth period by 20 days which simultaneously adversely affected the growth and yield-components, thereby discouraged the grain formation over straw. On the other hand, the HI was recorded more due to increased levels of nitrogen. The fact is that the nitrogen, one of the major nutrient elements, proved most beneficial in the enchancement of growth and yield components. That means, more photosynthates were diverted from the source (vegetative parts) towards the sink (reproductive i.e. yield-attributing parts) of plant development. It may be expressed in other words that the improvement in HI by balanced and sufficient N fertilization might be attributed to better partitioning of dry matter into grain portion.

5.7 Economics of the treatments :

Economics of the treatments in directly related to the success of that particular treatment and the extra input and output due to that treatment. The same facts apply to the grain and straw produce obtained from different barley varieties. Since RD 2552 and then DL 88 resulted with much more grain and straw yield as compared to RD 2503 and K 560 varieties, hence the total market sale of produce of these two varieties was higher and consequently the net return per hectare i.e. Rs. 16,729 and

Rs.15,483/ha respectively. The late sowing by 20 days resulted in considerable reduction in net return by Rs. 1615/ha as compared to normal sowing (7 November). This may be due to reduction in grain and straw yield on account of late sowing which decreased the total market sale of the produce. The highest nitrogen level (N_{90}) gave the additional net return by Rs. 7,955/ha over no nitrogen (No). This was because of the higher grain and straw yield obtained under highest N level (N_{90}) which ultimately enhanced the total market sale of the produce.

The calculation of benefit : cost ratio (B:C ratio) is the another way of expressing the economics of the treatments. It is based on the gross income against the total expenditure incurred on that particular treatment. In the present study, RD 2552 and then DL 88 resulted in the higher B:C ratio as compared to those of other varieties. The late sowing discouraged this ratio, while increasing N levels increased it.

5.8 Protein in grains :

In the present investigation, the barley variety K 560 recorded significantly higher seed protein as compared to other varieties viz. RD 2503, RD 2552 and DL 88. However, grain yield per hectare was found highest in variety RD 2552. This denotes the fact that the improved variety like RD 2552 enriched with high - yielding character was not found to be high in protein content.

However, plant breeder's efforts are under way to evolve the varieties possessing both these desirable characters in it. The higher seed protein content in variety may be due to higher total nitrate reductase (NR) activity during the grain filling period in the variety than other varieties (Biswas and Singh, 1982).

The increasing N levels increased the seed protein significantly. This has resulted due to more absorption of nitrogen by plants and the translocation of absorbed nitrogen from source (vegetative parts) to the sink (reproductive organs).

In fact nitrogen is the integral part of protein and both are so related that seed protein is obtained by multiplying percent N - content in seed with a standard factor 6.25. More protein yield due to applied N in the form of nitrate (NO_3) is reduced to ammonia (NH_3) which is then converted to amino acids. The proteins are formed by the fusion of he amino acids liberating the water molecules. Late sowing enhanced the seed protein which may be due to increased translocation of nitrogen from source (vegetative parts) to the sink (reproductive organs) owing to the curtailment of vegetative growth period.

5.9 Correlation studies :

The correlation analysis of vegetative growth parameters (plant population and number of tillers/running meter and per plant) and yield components (number of functional leaves/plant

and number of spikes/plant and spike length) with grain yield of barley reveal that those were more or less positively correlated in both the years (r=0.22 to r=0.72 in I year, and r=0.30 to r=0.74 in 2nd year). Among the yield components, functional leaves and spikes/plant had highly significant correlation with grain yield. (r=0.68 to 0.72 in I year, and r=0.67 to 0.74 in II year) The other character viz. tillers and spike length etc. had no positive correlation upto that extent with the grain yield. The yield components had direct impact contribution on grain yield, hence highly significant correlation with grain yield was eventual. the growth characters (plant population and number of tillers etc.) had indirect contribution to the grain yield, hence their correlation with grain yield was not upto that extent. Similar results have been reported by many workers (Sethi *et al.*, 1972; Sharma and Sharma, 1976; Khumkar *et al.*, 2001).

Summary mean table - 1

Treatments	Plant population /m row length	No of tillers /m row length		No of tillers /plant	
Main plot treatment					
Varieties	30 Days	60 Days	90 Days	30 Days	60 Days
V_1 -(RD 2503)	23.79	104.37	102.56	3.08	4.29
V_2 -(RD 2552)	25.61	167.58	165.91	4.43	6.54
V_3 -(K-560)	26.94	153.25	151.71	4.06	5.64
V_4 -(DL 88)	24.72	124.99	123.41	3.70	5.00
C.D. (5%)	0.58	10.13	9.61	0.53	0.41
Sub plot treatments					
Date of sowing					
D_1 - (7 November)	26.70	154.61	152.92	4.20	5.72
D_2- (27November)	23.79	135.5	118.88	3.43	5.01
C.D. (5%)	0.41	7.18	6.27	0.12	0.28
Sub-sub plot treatments					
N. levels (kg/ha)					
N_0 -(control)	24.31	115.16	113.58	3.2	4.68
N_{30} - (30 kg/ha)	24.97	127.66	126.12	3.58	5.01
N_{60} -(60 kg/ha)	25.54	146.25	144.50	4.04	5.77
N_{90} -(90 kg/ha)	26.17	161.12	159.39	4.45	6.10
C.D. (5%)	0.66	10.68	10.58	0.43	0.47
Interactions					
V x D	0.16	N.S.	N.S.	N.S.	N.S.
V x N	N.S.	N.S.	N.S.	N.S.	N.S.
D x N	N.S.	N.S.	N.S.	N.S.	N.S.
V x D x N	N.S.	N.S.	N.S.	N.S.	N.S.

Summary mean table - 2

Treatments	Plant height (cm.)				Fresh weight / plant (gm.)			
Main plot treatments								
Varieties	30 Days	60 Days	90 Days	Maturity	30 Days	60 Days	90 Days	Maturity
V_1-(R.D.2503)	15.45	37.37	81.89	86.21	13.14	47.00	327.35	147.12
V_2-(R.D.2552)	17.20	40.73	84.75	90.24	16.65	64.85	417.40	189.27
V_3-(K.560)	20.76	50.15	90.91	95.03	12.32	38.76	369.57	102.50
V_4-(DL.88)	18.96	45.47	87.92	92.96	15.36	55.95	363.54	167.80
C.D.(5%)	01.71	2.38	1.23	3.62	0.34	2.65	2.13	2.60
Sub plot treatments								
Date of sowing								
D_1-(7th November)	19.05	45.33	88.43	93.94	14.79	54.41	357.74	158.92
D_2-(27th November)	17.14	41.54	84.30	88.28	13.95	48.88	331.19	144.92
C.D.(5%)	0.74	1.26	0.87	2.70	0.54	1.72	1.32	0.80
Sub sub plot treatments								
Nitrogen levels (Kg/ha.)								
N_1-(Control)	14.98	37.52	78.47	86.95	12.48	41.87	300.56	123.64
N_2-(30 Kg/ha.)	16.98	41.61	81.19	89.06	13.44	48.04	328.72	143.60
N_3-(60 Kg/ha.)	19.39	45.50	85.52	92.50	15.05	54.92	359.72	161.95
N_4-(90 Kg/ha.)	21.03	49.10	90.18	95.92	16.48	61.75	388.86	177.50
C.D.(5%)	01.07	1.61	1.33	2.99	0.50	1.88	1.73	2.01
Interaction								
VxD	N.S.	0.64	N.S.	N.S.	N.S.	N.S.	2.64	2.61
VxN	N.S.	N.S.	N.S.	N.S.	0.23	3.80	3.47	4.01
DxN	N.S.	N.S.	0.89	N.S.	N.S.	N.S.	N.S.	3.83
VxDxN	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.50	2.81

Summary mean table -3

Treatments	No of functional leaves/ plant			Leaf area index		
Main plot treatments						
Varieties	30 days	60 days	90 days	30 days	60 days	90 days
V_1-(R.D.2503)	12.56	26.18	23.99	0.91	2.24	2.36
V_2-(R.D.2552)	13.50	28.56	26.75	1.00	2.50	2.69
V_3-(K.560)	11.81	24.81	22.56	0.83	2.06	2.20
V_4-(DL.88)	13.06	27.62	25.74	0.95	2.40	2.56
C.D.(5%)	0.81	1.66	1.68	0.03	0.04	0.03
Sub plot treatments						
Date of sowing						
D_1-(7th November)	14.18	28.53	26.15	1.04	2.47	2.60
D_2-(27th November)	11.28	25.06	23.37	0.80	2.13	2.31
C.D.(5%)	0.89	1.28	0.98	0.01	0.03	0.04
Sub sub plot treatments						
Nitrogen levels (Kg/ha.)						
N_1-(Control)	11.81	24.31	22.81	0.82	2.05	2.21
N_2-(30 Kg/ha.)	12.25	25.81	24.12	0.88	2.20	2.36
N_3-(60 Kg/ha.)	13.06	27.56	25.50	0.96	2.38	2.54
N_4-(90 Kg/ha.)	13.81	29.49	26.62	1.02	2.57	2.70
C.D.(5%)	0.86	1.28	1.14	0.02	0.02	0.02
Interaction						
VxD	N.S.	N.S.	N.S.	N.S.	0.01	0.04
VxN	N.S.	N.S.	N.S.	0.01	0.02	0.06
DxN	N.S.	N.S.	N.S.	N.S.	0.01	0.04
VxDxN	N.S.	N.S.	N.S.	N.S.	0.01	0.04

Summary mean table -4

Treatments	Dry weight/ plant (gm)			
Main plot treatments	30 days	60 days	90 days	Maturity
Varieties				
V_1 -RD 2503	6.25	27.75	88.78	140.06
V_2 -RD 2552	8.3	32.68	134.69	182.13
V_3 -K-560	5.65	23.41	65.96	94.59
V_4 -DL 88	7.29	32.47	114.39	159.35
C.D. (5%)	0.19	02.28	0.89	2.27
Sub plot treatments				
Date of sowing				
D_1 - (7 November)	7.24	31.87	107.15	151.37
D_2- (27November)	6.50	28.79	94.77	136.69
C.D. (5%)	0.09	02.10	0.60	1.15
Sub-sub plot treatments				
N. levels (kg/ha)				
N_0 -(control)	5.86	24.84	83.90	114.66
N_{30} - (30 Kg/ha)	6.32	28.40	93.18	136.03
N_{60} -(60 Kg/ha)	7.19	32.06	106.56	155.10
N_{90} -(90 Kg/ha)	8.11	35.90	120.20	170.32
C.D. (5%)	0.12	2.41	1.47	2.01
Interactions				
V x D	0.18	N.S.	1.21	2.31
V x N	0.02	N.S.	0.73	4.03
D x N	0.17	N.S.	N.S.	2.85
V x D x N	0.01	N.S.	0.50	2.72

Summary mean table -5

Treatments	Yield attributes at a glance (a)					
Main plot treatments **Varieties**	No of spikes / plant	Spike length (cm)	No of spikelets /spike	No of grains /spike	Grain weight /spike (gm)	Test weight of 1000grains(gm)
V_1 -RD 2503	4.08	6.06	17.68	51.31	2.05	39.95
V_2 -RD 2552	6.29	8.98	12.10	65.12	2.72	41.79
V_3 -K-560	3.74	9.80	23.83	68.81	2.94	42.77
V_4 -DL 88	4.75	7.59	19.53	56.50	2.22	39.25
C.D. (5%)	0.32	0.65	0.65	2.10	0.02	0.14
Sub plot treatments						
Date of sowing						
D_1 - (7 November)	5.07	8.61	22.96	66.47	2.74	41.12
D_2- (27November)	4.36	7.61	18.68	54.40	2.22	40.76
C.D. (5%)	0.36	0.43	0.40	0.96	0.01	0.10
Sub-sub plot treatments						
N. levels (kg/ha)						
N_0 -(control)	3.96	7.00	18.41	53.18	2.16	40.60
N_{30} - (30 Kg/ha)	4.33	7.68	19.91	57.75	2.37	40.95
N_{60} -(60 Kg/ha)	5.04	8.52	21.64	62.81	2.58	41.04
N_{90} -(90 Kg/ha)	5.52	9.35	23.31	68.00	2.80	41.18
C.D. (5%)	0.48	0.53	0.61	1.26	0.01	0.16
Interactions						
V x D	N.S.	N.S.	N.S.	0.48	0.03	N.S.
V x N	N.S.	N.S.	N.S.	N.S.	0.02	2.6
D x N	N.S.	N.S.	0.49	1.78	0.01	1.8
V x D x N	N.S.	N.S.	N.S.	N.S.	0.02	1.92

Summary mean table -6

Treatments	Yield attributes at a glance (b)					
Main plot treatments Varieties	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Net return /ha (Rs/~~Ha~~)	Benefit : cost rate ratio	Grain protein (%)
V_1 -RD 2503	37.29	61.28	37.74	14403	1.57	10.57
V_2 -RD 2552	41.70	64.81	38.98	16729	1.80	12.01
V_3 -K-560	33.10	57.02	36.48	11652	1.23	12.60
V_4 -DL 88	40.05	63.44	38.50	15483	1.63	11.53
C.D. (5%)	1.36	3.25	0.98			0.02
Sub plot treatments						
Date of sowing						
D_1 - (7 November)	39.40	62.67	38.42	15374	1.55	11.63
D_2- (27November)	36.66	60.60	37.42	13759	1.46	11.73
C.D. (5%)	0.61	2.16	0.77			0.02
Sub-sub plot treat.						
N. levels (kg/ha)						
N_0 -(control)	31.41	56.44	35.91	10840	1.17	11.30
N_{30} - (30 Kg/ha)	35.19	60.17	36.91	13028	1.39	11.52
N_{60} -(60 Kg/ha)	40.01	62.21	38.94	15603	1.66	11.91
N_{90} -(90 Kg/ha)	45.50	67.73	40.18	18795	2.00	12.23
C.D. (5%)	1.05	2.24	0.85			0.02
Interactions						
V x D	N.S.	N.S.	N.S.			0.03
V x N	0.9	N.S.	N.S.			0.04
D x N	N.S.	N.S.	N.S.			0.01
V x D x N	N.S.	N.S.	N.S.			0.03

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

Summary

The experiment entitled "**Studies on yield and quality of barley varieties in relation to sowing dates and nitrogen levels under irrigated conditions in Bundelkhand**" was carried out during winter season of I year and II year at the Research Farm of Brahmanand P.G. College, Rath, Distt. Hamirpur (U.P.) The objectives of the present investigation ~~was~~ were as follows:

1. To know the relative performance of new barley varieties under irrigated conditions in Bundelkhand region.
2. To determine the influence of nitrogen levels on production and malt quality traits of barley under irrigated conditions.
3. To find out the most suitable time for sowing under irrigated conditions of Bundelkhand.
4. To find our the most suitable combination of variety date of sowing and nitrogen level on growth yield and quality of barley for irrigated conditions in Bundelkhand Region.
5. To work out the economics of the various treatments.

The soil of the experimental field was silty loam (*Paruwa*) with uniform in fertility. The chemical composition of the field soil

was pH 7.6-7.8, electrical conductivity 0.23-0.40 d S/m, organic carbon 0.49-0.53%, available N, $P_2 O_5$ and K_2O) 165, 183 kg. 26.80 - 26.84 kg, 207.8-208.5 kg/ha respectively and calcium carbonate 4.78-4.80% in both the years. The total rainfall received during the crop season (November to March) was 10.5 mm and 5.7 mm in the respective years. The treatments comprised of four varieties (RD 2503, RD 2552, K 560 and DL 88) in the main plots, two dates of sowing (normal 7 November and late 27 November) in sub plots, and four nitrogen levels (0.30, 60 and 90 kg/ha) in the sub-sub plots. The experiment was laid out in double split plot design with three replications. Barley varieties were sown @ 100 kg seed/ha in rows 23 cm apart with 10 rows per plot. The application 40 kg $P_2 O_5$ and 20 Kg K_2O/ha along with half the pertinent levels of nitrogen was done as basal (before sowing) and the remaining half of the nitrogen was applied after 45 days of sowing. Nitrogen, phosphorus and potash was applied through urea, single superphosphate and nutriant of potash respectively. In all two irrigations were given at 30 and 60 days stages of the crop growth. Hand weeding was performed after 35 days of sowing. The crop was harvested on 6 and 30 March in the respective years.

The salient findings based on two seasons work as summarized as below :

6.1 Growth characters :

The plant height and dry weight /plant was, in general, enhanced by multi-fold with the enhancement of plant growth and development in successive stages till maturity stage. However, the fresh weight /plant and leaf area index were enhanced only upto 90 days stage. Abrupt multi-fold rise in fresh weight/plant was observed between 60 and 90 days stages. The number of functional leaves/plant and tillers/metre row length were increased only upto 60 days stage, thereafter a decline was noticed.

As regards with the effect of various treatments on growth behaviour it is alluded that the variety K 560 proved the tallest one, followed by DL 88, while RD 2503 measured the dwarfest one. In case of number of tillers/metre length and per plant, the variety RD 2552 proved the best at every stage, followed by K 560 and DL 88 and RD 2503 gave the lowest tiller numbers. The other four characters viz. functional leaves/plant, leaf area index, fresh and dry weight/plnat were found highest in variety RD 2552, followed by DL 88 and then RD 2503, the lowest being in case of K 560 at every stage of plant growth.

Late sowing of barley varieties by 20 days (27 November) discouraged significantly all the growth and development characters under study at every stage, however nitrogen application upto 80 kg/ha encouraged all these characters significantly at every stage.

6.2 Yield attributes :

RD 2552 recorded maximum spikes/plant. however, other five yield attributes (spike lenght, spikelets/spike, number and weight of grains/spike and 1000 grain weight) were maximum in K 560.The second best variety was RD 2552 with respect to all these five characters. RD 2503 gave the lowest performance.

Late sowing of barley varieties by 20 days significantly decreased all the yield attributes, whereas applied nitrogen upto 80 kg/ha increased them significantly over the preceding N levels.

6.3 Grain straw yield :

The variety RD 2552 proved to be the top yielder producing 41.70 q/ha grain and 64.81 q/ha straw. The second best variety was DL 88 which yielded 40.05 and 63.44 q/ha respectively. The lowest yielder variety was K560 producing 33.10 q/ha grain and 57.02 q/ha straw. The number of spikes/plant represented the major yield attribute which was exhibited in terms of highest yield from RD 2552 because this variety possessed the maximum spikes/ plant.

The grain and straw yield of barley varieties was significantly reduced by 2.74 and 2.07 q/ha respectively when sown 20 days late i.e. 27 November as against the normal sowing date (7 November).

Application of 30, 60 and 90 kg N/ha significantly increased the grain yield by 3.78, 8.60 and 14.09 q/ha respectively over no nitrogen. Similar increases in straw yield were 3.73, 5.77 and 11.29 q/ha due to respective N levels.

6.4 Harvest index (HI) :

The higher HI i.e. 38.50 and 38.98% was recorded in variety DL 88 and RD 2552 respectively. This was followed by RD 2503 (37.74%) and the lowest in K 560 (36.48%). The increased HI may be on account of increased photosynthates in these varieties which were diverted from the vegetative parts to the reproductive parts, thereby forming more seed over the straw. Late sowing discouraged this parameter, while increasing N levels encouraged it significantly.

6.5 Economics of the treatments :

Since RD 2552 and then DL 88 resulted with much more grain and straw yield over RD 2503 and K560 varieties, therefore the total market sale of these two varieties was higher and thereby the net return per hectare i.e. Rs. 16,729 and Rs. 15,483/ha respectively. The late sowing by 20 days resulted in considerable reduction in net return by Rs. 1,615/ha as compared to the normal sowing (7 November). The highest nitrogen level (N_{90}) gave the additional net return by Rs. 7,955/ha over no nitrogen. The benefit : cost ratio eventually followed the same trend as noticed in case

of net return from the best treatments.

6.6 Protein in grain :

The variety K 560 recorded significantly higher seed protein (12.58 to 12.63%) over rest of the varieties. Increasing nitrogen levels from 30 to 90 kg/ha increased the seed protein significantly. The barley varieties when sown on 27 November (late) prooved beneficial in enhancing the seed protein content as compared to 7 November early sowing.

6.7 Correlation studies :

Number of tillers/plant, functional leaves and spikes/plant had highly significant correlation with the grain yield of barley (r=0.50 to r=0.74).

Conclusion

Among the barley varieties RD 2552 proved to be the top yielder (41.70 q grain/ha) with the maximum net return upto Rs. 16,729/ha. The harvest index and benefit : cost ratio were also found highest i.e. 38.98% and 1.80 respectively. However, the grain protein was found highest in variety K 560 (12.58-12.63%). The second best variety suitable for Bundelkhand region was DL 88. The sowing of these varieties should not be delayed 7 November onward other wise the yields would be reduced. The varieties responded very well upto 90 kg N/ha, hence for achieving maximum productivity of barley nitrogen application should not be less than this dose.

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APPENDICES

APPENDIX-1 : Analysis of variance for various growth characters

Source of Variations	D.F.	Plant population / m row length 30 days				No. of tillers/m row length							
						60 days				90 days			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	**F. Value**	**M.S.S.**	**F. Value**	**M.S.S.**	**F. Value**	**M.S.S.**	**F. Value**	**M.S.S.**	**F. Value**	**M.S.S.**	**F. Value**
Replication	2	4.2	2.28	0.07	0.72	490.04	2.93	894.62	3.6	294.49	1.54	1546.87	8.62
V	3	50.07	28.33*	40.45	401.76*	22943.89	137.27*	16399.95	66.08*	22585.45	118.43*	16537.03	92.18*
Error(a)	6	1.78		0.1		167.14		248.19		190.71		179.39	
D	1	150	75.00*	256.76	2240.8*	24897	85.13*	30924.26	171.43*	24864.84	84.58*	30423.76	337.16*
V x D	3	3.25	1.63	1.23	10.76*	375.71	1.28	3.79	0.02	354.62	1.21	5.20	0.06
Error(b)	8	2		0.11		292.45		180.39		293.99		90.23	
N	3	16.6	7.68*	11.95	18.92*	13076.8	27.32*	7215.43	32.39*	12926.29	27.15*	7244.04	33.7*
V x N	9	0.33	0.15	0.22	0.35	185.82	0.39	23.06	0.1	201.58	0.42	22.00	0.10
D x N	3	0.11	0.05	0.18	0.28	173.4	0.36	96.7	0.43	190.06	0.40	96.26	0.45
VxDxN	9	0.47	0.22	0.17	0.27	118.85	0.25	10.93	0.05	109.21	0.23	11.96	0.06
Error(c)	48	2.16		0.63		478.6		222.79		476.15		214.97	
	95												

APPENDIX-2 : Analysis of variance for various growth characters

Source of Variations	D.F	No. of tillers per plant							
		30 days				60 days			
		I year		II year		I year		II year	
		M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value
Replicates	2	3.79	9.41	0.03	0.04	4.20	8.82	1.12	4.76
V	3	8.69	21.59*	6.46	8.27*	32.12	67.53*	14.11	59.76*
Error(a)	6	0.42		0.78		0.47		0.23	
D	1	16.67	66.67*	10.67	78.77*	15.84	43.46*	9.37	25.00*
V x D	3	0.03	0.11	0.08	0.62	0.45	1.25	0.04	0.11
Error(b)	8	0.25		0.13		0.36		0.37	
N	3	8.11	16.22*	7.51	12.23*	15.06	19.81*	5.64	9.67*
V x N	9	0.06	0.13	0.04	0.07	0.21	0.28	0.04	0.08
D x N	3	0.11	0.22	0.08	0.14	0.17	0.23	0.01	0.02
V x D x N	9	0.14	0.28	0.09	0.15	0.12	0.16	0.01	0.02
Error(c)	48	0.5		0.61		0.76		0.58	
	95								

APPENDIX-3(a) : Analysis of variance for various growth characters

Source of Variations	D.F.	Plant height (cm)							
		30 days				60 days			
		I year		II year		I year		II year	
		M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value
Replicates	2	23.04	4.75	40.1	5.66	25.18	1.97	126.07	12.41
V	3	103.8	21.40*	148.78	21.02*	606.21	47.51*	843.95	83.04*
Error(a)	6	4.85		7.08		12.76		10.16	
D	1	30.84	15.91*	172.86	55.66*	327.49	20.27*	185.93	99.73*
V x D	3	0.11	0.06	1.73	0.56	24.64	1.52	8.57	4.60*
Error(b)	8	1.94		3.1		16.16		1.86	
N	3	68.11	19.70*	318.42	95.44*	581.81	49.52*	544.26	120.96*
V x N	9	0.85	0.25	0.56	0.17	10.87	0.93	0.77	0.17
D x N	3	0.05	0.01	4.12	1.24	1.83	0.16	0.21	0.05
V x D x N	9	0.24	0.07	0.84	0.25	8.78	0.75	1.01	0.23
Error(c)	48	3.46		3.34		11.75		4.5	
	95								

APPENDIX-3(b) : Analysis of variance for various growth characters

Source of Variations	D.F	Plant height (cm)							
		60 days				Maturity			
		I year		II year		I year		II year	
		M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value
Replicates	2	21.6	8.64	2.55	0.7	68.59	1.15	6.26	0.97
V	3	294.41	117.73*	418.72	114.38*	554.50	9.3*	434.93	67.44*
Error(a)	6	2.5		3.66		59.66		6.45	
D	1	489.61	157.98*	423.95	113.72*	780.21	14.26*	392.04	23.48*
VXD	3	4.51	1.45	4.05	1.09	37.09	0.68	5.23	0.31
Error(b)	8	3.11		3.73		54.73		16.63	
N	3	692.37	145.93*	277.82	47.64*	450.5	6.38*	575.47	156.64*
VXN	9	1.35	0.29	3.25	0.56	67.88	0.96	177	0.48
DXN	3	45.58	9.61*	308	0.53	38.99	0.55	6.96	1.89
VXDXN	9	8.6	1.81	2.59	0.44	64.22	0.91	1.37	0.37
Error(c)	48	4.74		5.83		70.57		3.68	
	95								

APPENDIX-4 : Analysis of variance for various growth characters

Source of Variations	D.F	No. of functional leaves/plant											
		30 days				60 days				90 days			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	1.78	1.35	9.5	7.13	18.37	3.42	4.34	0.77	5.28	0.83	0.41	0.08
V	3	10.84	8.2*	13.37	10.03*	39.37	7.33*	83.40	14.73*	63.09	9.91*	106.25	21.29*
Error(a)	6	1.32		1.33		5.37		5.66		6.36		4.90	
D	1	189.84	37.97*	198.37	79.35*	294	34.34	198.37	31.63*	157.59	32.54*	216.00	53.58*
VXD	3	1.09	0.22	0.37	0.15	1.5	0.18	3.4	0.54	3.40	0.69	0.75	0.19
Error(b)	8	5		2.5		8.56		6.27		4.84		4.03	
N	3	28.09	9.74*	14.62	8.89*	109.62	18.11*	91.62	23.84*	54.09	10.45*	78.75	28.42*
V x N	9	0.67	0.23	0.62	0.38	0.62	0.1	7.32	1.9	0.51	0.10	0.83	0.30
D x N	3	0.34	0.12	0.12	0.08	0.75	0.12	17.62	4.59*	5.34	1.03	0.75	0.27
V x D x N	9	1.26	0.44	0.12	0.08	0.58	0.1	7.32	1.9	0.76	0.15	1.50	0.54
Error(c)	48	2.88		1.64		6.05		3.84		5.18		2.77	
	95												

APPENDIX-5 : Analysis of variance for various growth characters

Source of Variations	D F	Leaf area index/plant (%)											
		30 days				60 days				90 days			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	0	0.09	0	0.48	-	0.24	0	2.29	0.02	10.68	0.00	1.56
V	3	0.11	37.46*	0.15	170.01	0.50	49.89*	1.30	2776.8*	0.84	487.63*	1.47	550.89*
Error(a)	6	0		0		0.01		0		0.00		0.00	
D	1	1.31	1195.57*	1.47	1811.21*	2.35	214.95*	2.81	9052.23*	1.75	1459.42*	2.35	1538.54*
V x D	3	0	1.09	0	2.31	0	0.07	0.04	150.56*	0.03	28.16*	0.01	5.08*
Error(b)	8	0		0		0.01		0		0.00		0.00	
N	3	0.21	68.67*	0.17	344.71*	1.2	188.5*	1.42	2428.6*	0.85	513.84*	1.32	431.17*
V x N	9	0	0.19	0	7.24*	0	0.86	0.01	25.14*	0.00	3.17*	0.01	2.61*
D x N	3	0.01	2.3	0	1.4	0	0.45	0.04	75.72*	0.05	31.91*	0.01	4.11*
V x D x N	9	0	1.09	0	1.27	0.01	1.95	0.01	13.6*	0.00	3.43*	0.01	4.82*\
Error(c)	48	0		0		0.01		0		0.00		0.00	
	95												

APPENDIX-6(a) : Analysis of variance for various growth characters

Source of Variations	D.F.	Fresh weight/plant (gm)							
		30 days				60 days			
		I year		II year		I year		II year	
		M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value
Replicates	2	0	0.04	3.77	10.02	69.42	3.95	27.84	2.52
V	3	60.92	443.3*	142.27	378.11*	2945.12	167.72*	3048.36	275.8*
Error(a)	6	0.14		0.37		17.56		11.05	
D	1	13.1	28.89*	15.96	6.05*	730.74	52.8*	696.39	53.81*
V x D	3	0.09	0.2	0.33	0.13	3.88	0.28	4.71	0.36
Error(b)	8	0.45		2.64		13.84		12.94	
N	3	41.31	251.57*	93.18	51.08*	1526.73	148.69*	1977.01	183.58*
V x N	9	1.79	10.89*	2.84	1.56	22.54	2.2*	30.62	2.84
D x N	3	0.24	1.47	1.28	0.67	0.91	0.09	0.72	0.07
V x D x N	9	0.14	0.87	0.45	0.25	3.43	0.33	3.05	0.28
Error©	48	0.16		1.82		10.27		10.77	
	95								

APPENDIX-6(b) : Analysis of variance for various growth characters

Source of Variations	D.F	Fresh weight/plant (gm)							
		60 days				Maturity			
		I year		II year		I year		II year	
		M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value	M.S.S.	F.Value
Replicates	2	10.79	2.34	3.73	0.25	77.21	6.27	15.39	1.03
V	3	93374.09	20214.26*	92073.9	6059.72*	33398.89	2713.84*	33042.21	2218.63*
Error(a)	6	4.62		15.19		12.31		14.89	
D	1	16906.51	2626.75*	16859.30	1784.23*	4683.86	401.67*	5132.35	1122.89*
V x D	3	452.67	70.33*	461.7	48.86*	224.2	19.23*	230.28	50.38
Error(b)	8	6.44		9.45		11.66		4.57	
N	3	34226.47	5957.18*	35980.7	2786*	12894.7	1581.49*	12806.8	776.05*
V x N	9	75.67	13.17*	80.99	6.27*	286.04	35.08*	324.2	19.65
D x N	3	0.70	0.12	1.01	0.08	44.78	5.49*	54.25	3.29
V x D x N	9	66.22	11.53	62.87	4.87*	80.43	9.86*	79.92	4.84
Error©	48	5.74		12.91		8.15		16.5	
	95								

APPENDIX-7(a) : Analysis of variance for various growth characters

Source of Variations	D.F.	Dry weight/plant (gm)							
		30 days				60 days			
		I year		II year		I year		II year	
		M.S.S.	**F.Value**	**M.S.S.**	**F.Value**	**M.S.S.**	**F.Value**	**M.S.S.**	**F.Value**
Replicates	2	0.00	4.09	0.18	0.64	178.94	19.59	47.49	4.00
V	3	26.30	42567.12*	39.91	141.56*	1036.90	113.49*	733.40	61.7*
Error(a)	6	0.00		0.28		9.14		11.89	
D	1	9.36	4760.98*	18.06	142.88*	368.48	13.23*	185.65	13.81*
V x D	3	0.15	76.79*	1.04	8.2*	5.04	0.18	2.19	0.16
Error(b)	8	0.00		0.13		27.85		13.44	
N	3	23.91	15403.04*	23.57	161.73*	474.11	23.99*	582.85	35.86*
V x N	9	0.60	384.75*	0.24	1.67*	21.03	1.06	5.63	0.38
D x N	3	0.60	389.98*	1.03	7.08*	11.20	0.57	0.01	0.00
V x D x N	9	0.48	309.67*	0.15	1.04	10.80	0.55	1.89	0.13
Error©	48	0.00		0.14		19.77		14.86	
	95								

APPENDIX-7(b) : Analysis of variance for various growth characters

Source of Variations	D.F.	Dry weight/plant (gm)								Protein content (%)			
		90 days				Maturity							
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	16.30	25.58	30.43	9.99	103.61	52.02	33.05	1.31	0.01	14.17	0.01	12.37
V	3	21638.06	33952.14*	21453.45	7044.71*	32961.39	16550.31*	31910.57	1261.38*	18.08	28535.47*	18.14	20856.15*
Error(a)	6	0.64		3.04		1.99		25.30		0.00		0.00	
D	1	3763.76	4104.3*	3606.40	1378.6*	4850.01	1995.78*	6450.61	572.84*	0.08	23.23*	0.14	504.81*
V x D	3	135.59	147.86*	133.81	51.15*	206.64	85.03*	383.43	34.05*	0.01	2.74*	0.00	18.3*
Error(b)	8	0.92		2.61		2.43		11.26		0.00		0.00	
N	3	5794.48	3634.57*	6247.02	429.91*	12949.90	3538.26*	14509.14	572.55*	5.52	2813.6*	5.67	9263.97*
V x N	9	18.38	11.53*	25.96	1.79	300.41	82.08*	248.84	9.82*	0.23	117.68*	0.21	351.31*
D x N	3	3.87	2.43	15.13	1.04	74.59	20.38*	107.45	4.24*	0.00	1.47	0.00	7.93*
V x D x N	9	4.75	2.98*	8.99	0.62	73.10	19.97*	84.09	3.32*	0.00	4.52*	0.00	10.17*
Error(c)	48	1.59		14.53		3.66		25.34		0.00		0.00	
	95												

APPENDIX-8(a) : Analysis of variance for various yield contributing characters

Source of Variations	D.F.	No. of spikes/plant				Spike lenght (cm)				No. of spikelets/spike			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	0.65	3.57	0.12	0.53	0.45	0.47	0.29	0.37	4.20	3.01	1.88	4.28
V	3	44.69	242.87*	16.94	71.76*	44.45	46.45*	89.56	115.48*	185.87	133.49*	177.68	402.98*
Error(a)	6	0.18		0.24		0.96		0.77		139.00		0.44	
D	1	18.37	24.16*	10.67	23.27*	29.37	52.39*	19.26	16.54*	437.76	433.25*	442.04	832.08*
V x D	3	0.18	0.24	0.22	0.48	1.93	3.44	0.91	0.79	4.09	4.05	140.00	2.64
Error(b)	8	0.76		0.45		0.56		1.16		1.01		0.53	
N	3	19.14	24.50*	6.80	11.14*	24.46	23.75*	21.53	31.72*	140.29	95.52*	78.62	97.60*
V x N	9	0.20	0.26	0.29	0.47	0.24	0.23	0.23	0.35	0.38	0.26	0.74	0.93
D x N	3	0.24	0.30	0.36	0.59	0.14	0.14	0.01	0.02	7.34	5.00	0.57	0.71
V x D x N	9	0.11	0.15	0.17	0.29	0.17	0.17	0.36	0.53	0.60	0.41	1.56	1.94
Error(c)	48	0.78		0.61		1.03		0.68		1.67		0.80	
	95												

APPENDIX-8(b) : Analysis of variance for various yield contributing characters

Source of Variations	D.F.	No. of grains/spike				Grain weight/spike				Test weight (gm)			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	18.01	2.37	1.32	0.13	0.00	1.94	0.00	0.80	0.12	1.03	18.83	1.02
V	3	1544.50	203.39*	1503.34	148.02*	4.09	4005.96*	4.29	6176.82*	64.22	558.09*	39.15	2.13*
Error(a)	6	7.59		10.16		0.00		0.00		0.11		18.39	
D	1	3577.04	3333.94*	3613.76	390.24*	6.33	6644.18*	6.37	6938.14*	2.91	23.36*	46.61	
V x D	3	25.71	23.96*	24.51	2.65	0.06	63.89*	0.05	58.76*	0.34	2.72	79.42	3.66
Error(b)	8	1.07		9.26		0.00		0.00		0.12		21.72	
N	3	1311.17	212.26*	755.76	219.86*	2.31	4005.06*	1.41	4636.17*	0.66	5.22*	58.75	2.94*
V x N	9	6.39	1.03	3.89	1.13	0.01	17.42*	0.00	15.46*	0.12	0.94	74.44	3.73*
D x N	3	75.71	12.26*	19.09	5.55	0.13	228.50*	0.02	72.96*	0.14	1.14	83.50	4.18*
V x D x N	9	6.60	1.07	8.73	2.54	0.01	22.69*	0.01	41.34*	0.09	0.70	75.01	3.76*
Error(c)	48	6.18		3.44		0.00		0.00		0.13		19.96	
	95												

APPENDIX-8(c) : Analysis of variance for various yield of crop

Source of Variations	D.F	Grain yield (q/ha.)				Straw yield (q/ha.)				Harvest index (%)			
		I Year		II Year		I Year		II Year		I Year		II Year	
		M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value	M.S.S.	F. Value
Replicates	2	17.50	4.90	27.29	6.95	73.18	3.93	6.39	0.27	0.06	0.04	1.65	0.70
V	3	308.14	86.3*	331.96	84.58*	287.24	15.44*	284.79	11.84*	35.09	23.20*	20.61	8.67*
Error(a)	6	3.57		3.92		18.60		24.05		1.51		2.38	
D	1	228.29	125.18*	174.23	106.11*	165.09	626*	51.93	3.16*	27.32	7.39*	17.78	9.43*
V x D	3	2.22	1.22	2.40	1.46	16.05	0.61	1.59	0.10	0.42	0.11	0.24	0.13
Error(b)	8	1.82		1.64		26.37		16.42		3.69		1.89	
N	3	999.73	401.88*	851.81	200.53*	503.23	25.44*	534.51	50.00*	101.45	54.46*	96..86	39.61*
V x N	9	8.77	3.53*	8.83	2.08	15.07	0.76	11.80	1.10	1.34	0.72	0.77	0.32
D x N	3	3.75	1.51	2.71	0.64	23.33	1.18	4.66	0.44	0.21	0.11	1.46	0.60
V x D x N	9	4.83	1.95	2.17	0.51	15.67	0.79	8.57	0.80	0.47	0.25	0.57	0.23
Error(c)	48	2.49		4.24		19.78		10.69		1.86		2.44	
	95												

Cost of cultivation (Rs/ha.) (I year)

S.n.	Particulars of expenditure	Cost (Rs)
1	Land preparation	
	(a) two deep ploughing	1000.00
	(b) harrowing and planking (one)	300.00
	(C) layout and drainage	300.00
2	Sowing operation (by seed cum fertilizer drill)	350.00
3	Cost of seed @ 100 kg / ha	700.00
4	Total urea (30,60,90 kg/ha)	1440.00
5	Uniform dose of 40 kg p_2o_5 /ha through s.s.p.	128.00
6	Uniform dose of 20 kg k_2o /ha through m.o.p.	116.00
7	Cost of seed treatment 300 g/a through thiram	48.00
8	Irrigation charges (two)	1000.00
9	Hand weeding and thinning (15 labour)	800.00
10	Harvesting (20) labourer	1000.00
11	Threshing and winnowing (20 labourer)	1000.00
12	Land revenue	30.00
13	Interest on working capital (6 months)	275.00
14	Miscellaneous	200.00
15	Others	20.00
	Total	8707.00

Prevailing market rates (I year)

S.n.	Particulars	Market rates (Rs)
1	One tractor ploughing (per hectare)	450.00
2	One disc harrowing and planking (per hectare)	300.00
3	Irrigation by electric pump (per hectare)	450.00
4	Labour charge (one)	50.00
5	Cost of fertilizer	
	(a) nitrogen (per kg) (through urea @ Rs 366/q)	8.00
	(b) phosphours (per kg) (through s.s.p. @ Rs 320/q)	3.20
	(C) potash (per kg) (through m.o.p. @ Rs 350/q)	5.83
6	Thiram for seed treatment (per kg)	160.00
7	Seed of barley (per quintal)	700.00
8	Grain of barley (per quintal)	500.00
9	Straw of barley (per quintal)	80.00
10	Land revenue tax (per hectare)	30.00
11	Interest on working capital @ 10% for half year	275.00

Cost of cultivation (Rs/ha) (II year)

S.n.	Particulars of expenditure	Cost (Rs)
1	Land preparation -	
	(a) two deep ploughing	1050.00
	(b) harrowing and planking (one)	300.00
	(C) layout and drainage	300.00
2	Sowing operation (by seed cum fertilizer drill)	350.00
3	Cost of seed @ 100 kg / ha	700.00
4	Total urea (30,60,90 kg/ha)	1450.00
5	Uniform dose of 40 kg p_2o_5 /ha through s.s.p.	130.00
6	Uniform dose of 20 kg k_2o /ha through m.o.p.	120.00
7	Cost of seed treatment 300 g/a through thiram	50.00
8	Irrigation charges (two)	1000.00
9	Hand weeding and thinning (15 labourer)	800.00
10	Harvesting (20) labourer	1000.00
11	Threshing and winnowing (20 labourer)	1000.00
12	Land revenue	32.00
13	Interest on working capital (6 months)	275.00
14	Miscellaneous	250.00
15	Others	20.00
	Total	8827.00

Prevailing market rates (II year)

S.n.	Particulars	Market rates (Rs)
1	One tractor ploughing (per hectare)	500.00
2	One disc harrowing and planking (per hectare)	300.00
3	Irrigation by electric pump (per hectare)	450.00
4	Labour charge (one)	50.00
5	Cost of fertilizer	
	(a) nitrogen (per kg) (through urea @Rs 366/q)	8.50
	(b) phosphours (per kg) (through s.s.p. @ Rs 320/q)	3.30
	(c) potash (per kg) (through m.o.p. @ Rs 350/q)	6.00
6	Thiram for seed treatment (per kg)	160.00
7	Seed of barley (per quintal)	700.00
8	Grain of barley (per quintal)	500.00
9	Straw of barley (per quintal)	80.00
10	Land revenue tax (per hectare)	30.00
11	Interest on working capital @ 10% for half year	275.00

General Cost of Cultivation (I Year)

Sl. no.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Value of grain yield (Rs/ha)	Value of straw yield (Rs/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Extra expenditure (Rs/ha)	Total expenditure (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
1	$V_1D_1N_0$	31.46	56.31	15730	4504	20234	8707	318	9025	11209	1.24
2	N_1	36.06	61.87	18030	4949	22979	8707	318	9025	13954	1.55
3	N_2	39.62	62.48	19810	4998	24808	8707	318	9025	15783	1.75
4	N_3	46.49	67.78	23245	5422	28667	8707	318	9025	19642	2.13
5	D_2N_0	29.20	54.75	14600	4380	18980	8707	398	9105	9875	1.08
6	N_1	32.41	57.35	16205	4588	20793	8707	398	9105	11688	1.28
7	N_2	37.8	60.39	18900	4831	23731	8707	398	9105	14626	1.61
8	N_3	41.54	62.71	20770	5016	25786	8707	398	9105	16681	1.83
9	$V_2D_1N_0$	36.06	59.53	18030	4762	22792	8707	478	9185	13607	1.48
10	N_1	39.97	64.31	19985	5144	25129	8707	478	9185	15944	1.75
11	N_2	46.06	66.48	23030	5318	28348	8707	478	9185	19163	2.09
12	N_3	49.53	71.26	24765	5700	30465	8707	478	9185	21280	2.32
13	D_2N_0	29.98	53.87	14990	4309	19299	8707	557	9264	10035	1.18
14	N_1	35.63	60.39	17815	4831	22646	8707	557	9264	13382	1.44
15	N_2	43.01	65.17	21505	5214	26719	8707	557	9264	17455	1.88
16	N_3	47.36	70.47	23680	5637	29317	8707	557	9264	20053	2.16

Sl. no.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Value of grain yield (Rs/ha)	Value of straw yield (Rs/ha)	Gross income (Rs/ha)	Cost of cultiva-tion (Rs/ha)	Extra expendi-ture (Rs/ha)	Total expenditure (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
17	$V_3D_1N_0$	27.29	52.14	13645	4171	17816	8707	637	9344	8472	0.91
18	N_1	30.15	54.31	15075	4344	19419	8707	637	9344	10075	1.08
19	N_2	33.19	56.05	16595	4484	21079	8707	637	9344	11735	1.25
20	N_3	41.54	64.31	20770	5144	25914	8707	637	9344	16570	1.77
21	D_2N_0	26.07	51.27	13035	4101	17136	8707	717	9424	7712	0.82
22	N_1	28.07	53.18	14035	4254	18289	8707	717	9424	8865	0.94
23	N_2	31.89	55.18	15945	4414	20359	8707	717	9424	10935	1.16
24	N_3	38.84	62.13	19420	4970	24390	8707	717	9424	14966	1.59
25	$V_4D_1N_0$	33.37	57.79	16685	4623	21308	8707	797	9504	11804	1.32
26	N_1	37.37	62.39	18685	4991	23676	8707	797	9504	14172	1.59
27	N_2	42.15	63.26	21075	5060	26135	8707	797	9504	16631	1.78
28	N_3	48.32	69.52	24160	5561	29721	8707	797	9504	20217	2.15
29	D_2N_0	29.80	55.18	14900	4414	19314	8707	877	9504	9730	1.09
30	N_1	35.10	60.83	17550	4866	22416	8707	877	9504	12832	1.34
31	N_2	40.41	61.87	20205	4949	25154	8707	877	9504	15570	1.65
32	N_3	46.06	69.08	23030	5526	28556	8707	877	9504	18972	1.98

General Cost of Cultivation (II Year)

Sl. no.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Value of grain yield (Rs/ha)	Value of straw yield (Rs/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Extra expenditure (Rs/ha)	Total expenditure (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
1	$V_1D_1N_0$	32.15	58.22	16075	4658	20733	8827	352	9179	11554	1.26
2	N_1	36.93	63.00	18465	5040	23505	8827	352	9179	14326	1.56
3	N_2	41.1	64.20	20550	5136	25686	8827	352	9179	16507	1.80
4	N_3	46.58	69.17	23290	5534	28824	8827	352	9179	19645	2.14
5	D_2N_0	30.15	56.53	15075	4522	19597	8827	438	9265	10332	1.11
6	N_1	33.55	58.57	16775	4682	21457	8827	438	9265	12192	1.32
7	N_2	39.45	61.52	19725	4921	24647	8827	438	9265	15382	1.66
8	N_3	42.15	65.70	21075	5256	26331	8827	438	9265	17066	1.84
9	$V_2D_1N_0$	36.84	62.20	18420	4976	23396	8827	518	9345	14051	1.50
10	N_1	41.36	65.35	20680	5228	25908	8827	518	9345	16563	1.77
11	N_2	47.19	67.78	23595	5422	29017	8827	518	9345	19672	2.11
12	N_3	50.49	71.69	25245	5735	30980	8827	518	9345	21635	2.35
13	D_2N_0	33.80	59.35	16900	4748	21648	8827	597	9424	12224	1.30
14	N_1	36.50	63.44	18250	5075	23325	8827	597	9424	13901	1.47
15	N_2	44.75	66.39	22375	5311	27686	8827	597	9424	18262	1.94
16	N_3	48.66	69.35	24330	5548	29878	8827	597	9424	20454	2.17

Sl. no.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Value of grain yield (Rs/ha)	Value of straw yield (Rs/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Extra expenditure (Rs/ha)	Total expenditure (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
17	$V_3D_1N_0$	30.15	55.35	15075	4428	19503	8827	677	9504	9999	1.05
18	N_1	32.5	55.7	16250	4456	20706	8827	677	9504	11202	1.18
19	N_2	34.41	57.01	17205	4561	21766	8827	677	9504	12262	1.29
20	N_3	42.75	65.61	21375	5298	26673	8827	677	9504	17169	1.8
21	D_2N_0	28.24	53.53	14120	4282	18402	8827	757	9584	8818	0.92
22	N_1	31.54	55.44	15770	4435	20205	8827	757	9584	10621	1.11
23	N_2	32.85	56.4	16425	4512	20937	8827	757	9584	11353	1.18
24	N_3	40.15	64.83	20075	5186	25261	8827	757	9584	15677	1.63
25	$V_4D_1N_0$	35.8	59.26	17900	4741	22641	8827	837	9664	12976	1.34
26	N_1	39.89	63.7	19945	5096	25041	8827	837	9664	15377	1.59
27	N_2	43.97	66.22	21985	5298	27283	8827	837	9664	17619	1.82
28	N_3	50.23	71.43	25115	5714	30829	8827	837	9664	21165	2.19
29	D_2N_0	32.33	57.88	16165	4630	20795	8827	917	9744	11051	1.13
30	N_1	36.15	63.00	18075	5040	23115	8827	917	9744	13371	1.37
31	N_2	42.49	65.09	21245	5207	26452	8827	917	9744	16708	1.71
32	N_3	47.45	68.65	23725	5558	29283	8827	917	9744	19539	2.00

PHOTOGRAPHS

Photo-1 **Prepairing plots for sowing seeds of various varieties of barley (*Hordeum vulgare L.*).**

Photo-2 **Sowing seeds of various varieties of barley (*Hordeum vulgare L.*).**

Photo-3 Grown barley (*Hordeum vulgare L.*) plants of various varieties (30 DAS, 7 November).

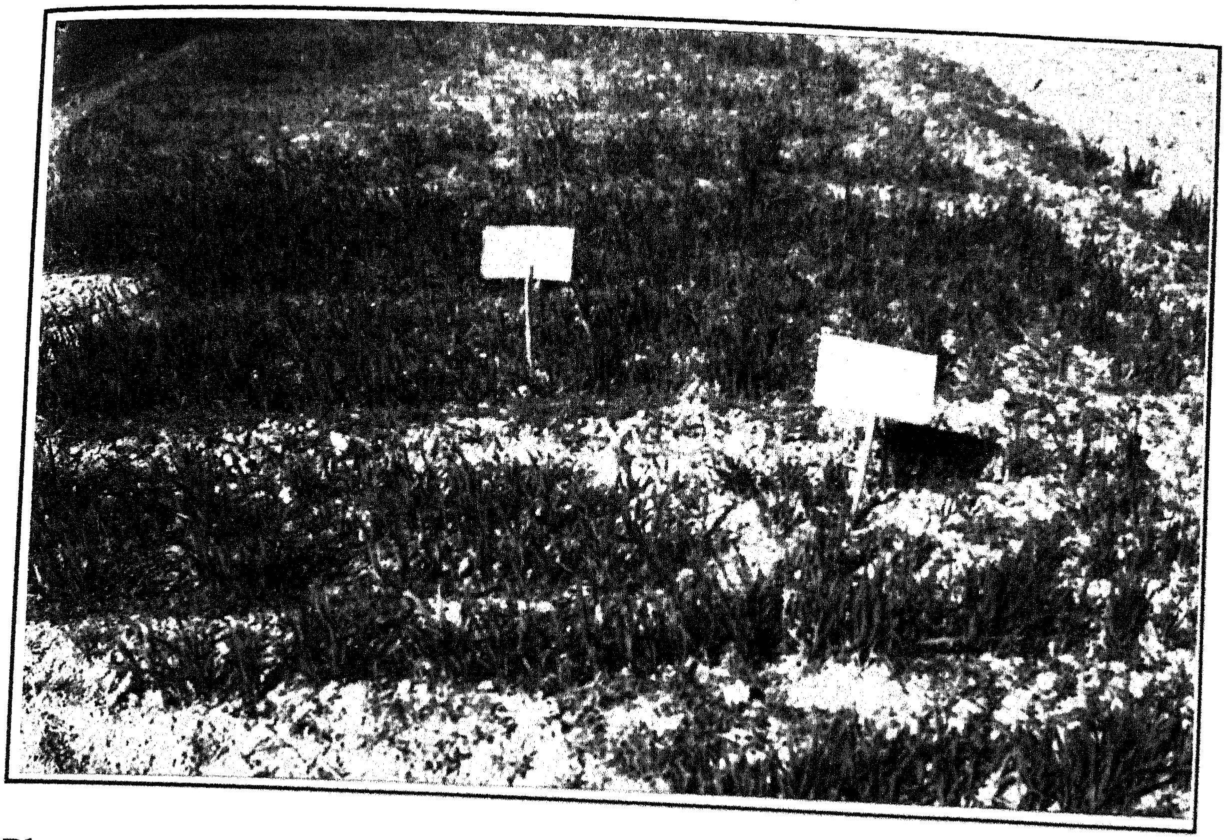

Photo-4 Grown barley (*Hordeum vulgare L.*) plants of various varieties (30 DAS, 7 & 27 November).

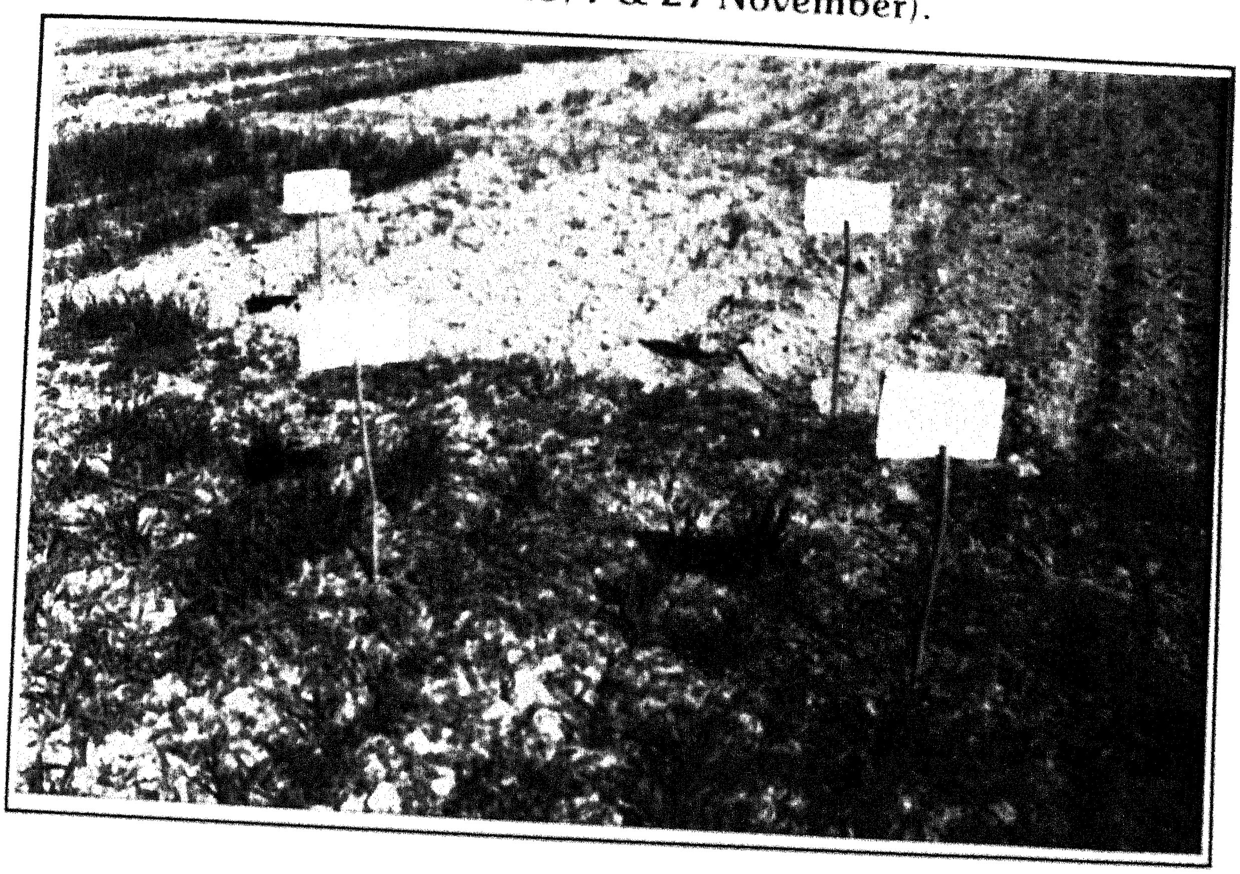

Photo-5 Grown barley (*Hordeum vulgare L.*) plants of various varieties (90 DAS, 7 & 27 November).

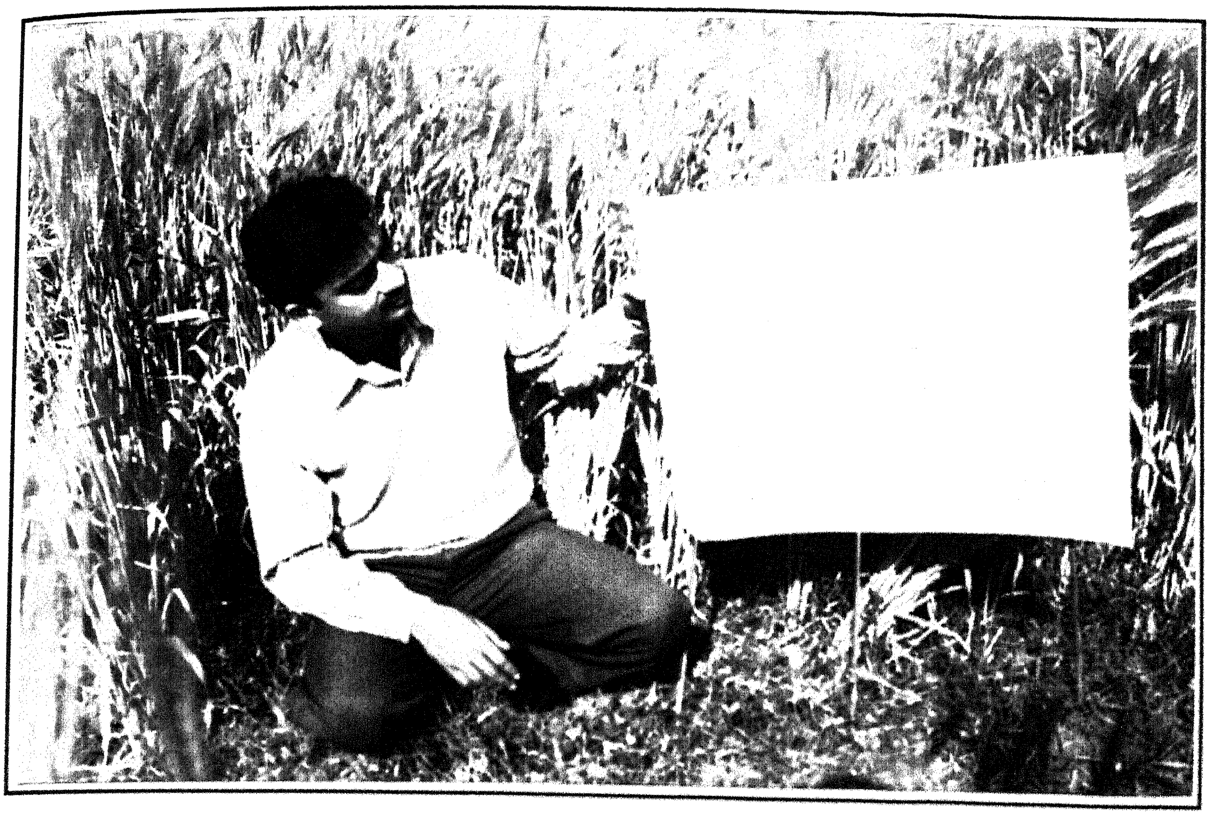

Photo-6 Grown barley (*Hordeum vulgare L.*) plants of various varieties (90 DAS, 7 & 27 November).

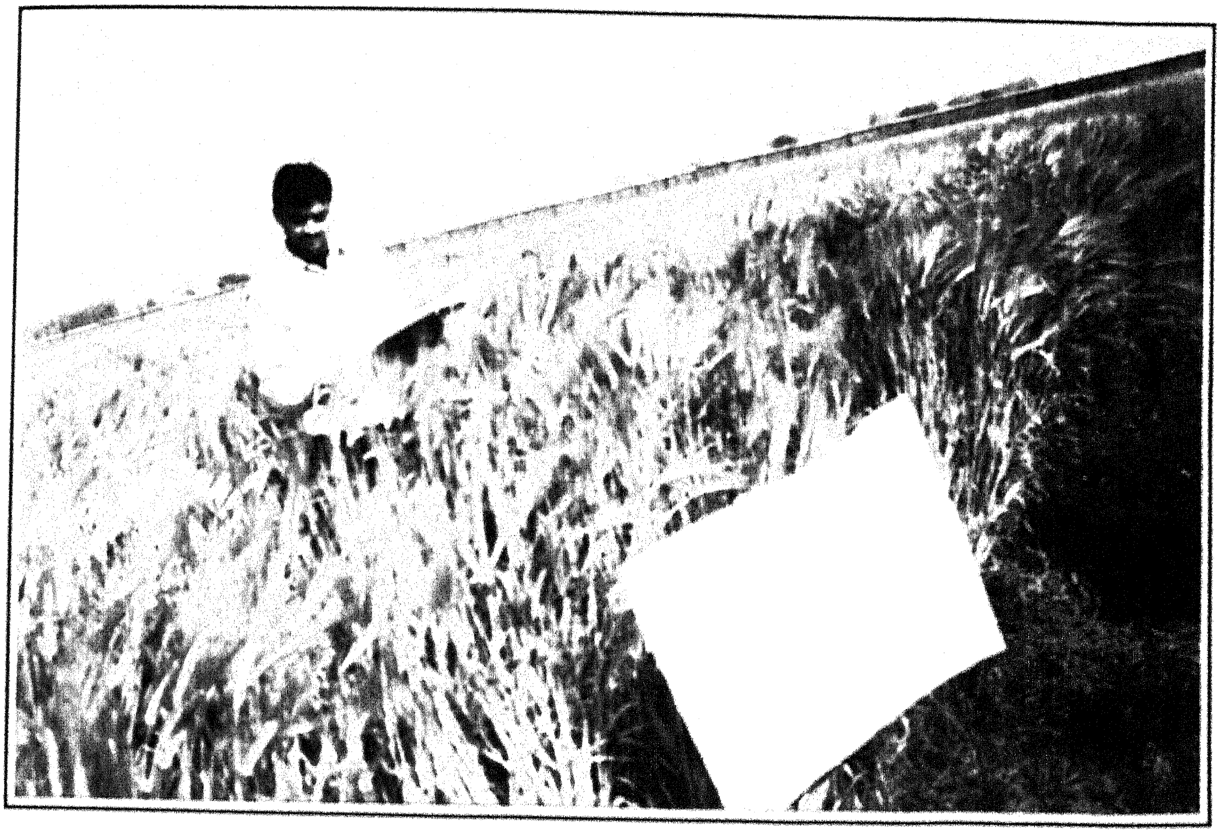

Photo-7 Weeding of grown barley (*Hordeum vulgare L.*) plots.

Photo-8 Harvesting of barley (*Hordeum vulgare L.*) plots.

Photo-9 Threshing of barley (*Hordeum vulgare L.*) per plot

Photo-10 4 varieties of barley (*Hordeum vulgare L.*) sample plants

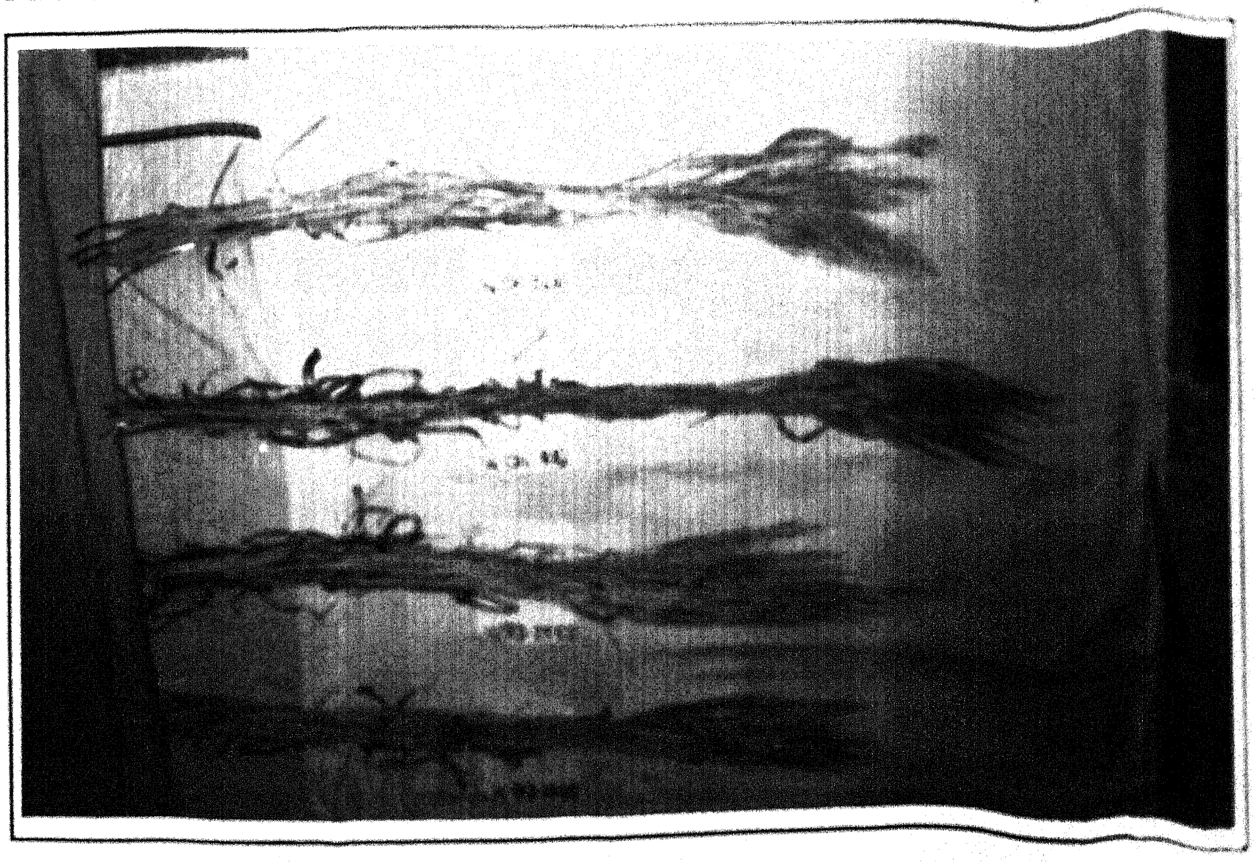

Photo-11 Seeds of barley (*Hordeum vulgare L.*) varieties RD-2503 and RD-2552.

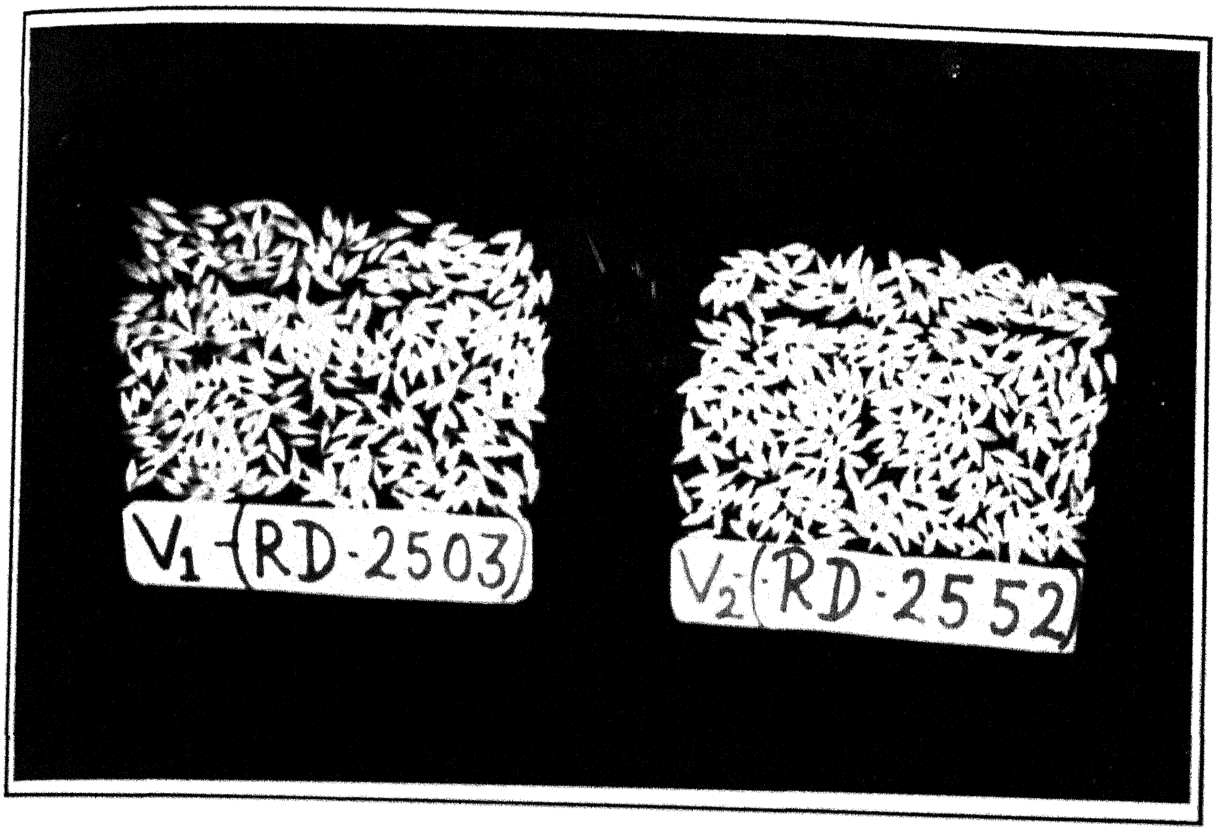

Photo-12 Seeds of barley (*Hordeum vulgare L.*) varieties DL-88 and K-560.